MAILED
5-20-09

Montana Department of
ENVIRONMENTAL QUALITY

Brian Schweitzer, Governor

P.O. Box 200901 • Helena, MT 59620-0901 • (406) 444-2544 • www.deq.mt.gov

May 20, 2009

Mr. Gary Keeler, *Manager*
BUTTE-SILVER BOW LANDFILL
126 West Granite Street
Butte, MT 59701-9216

RE: **CLOSED BUTTE-SILVER BOW COUNTY LANDFILL – LICENSE #20**
EVALUATION OF THE EFFECTIVENESS OF THE CORRECTIVE MEASURES

Dear Mr. Keeler:

The Department has reviewed the Evaluation of the Effectiveness of the Corrective Measures for the closed Butte-Silver Bow County Class II Landfill, in Butte, MT. The Department generally agrees with the conclusions of the report. Re-evaluation of the overall effectiveness of the corrective measures should be conducted every 5 years. The trends in VOC concentrations should continue to be evaluated after each sampling event.

If you have any questions or comments regarding this review, please contact me directly at the Permitting and Compliance Division, Waste and Underground Tank Management Bureau, Solid Waste Section.

Sincerely,

Martin Van Oort
Environmental Science Specialist
Solid Waste Program
Phone: 406-444-2802, Fax: 406-444-1374
E-mail: mvanoort@mt.gov

File: Closed\Silver Bow Co.\Butte-Silver Bow Class II\License #20\Groundwater Corrective Measures
Path: G:\WUT\SWS\GWater\Responses\Silver Bow Co\2009-05_cl_bsb_20_CM.doc
cc: Mr. Shawn Bisch, Pioneer Technical Services, PO Box 3445, Butte, MT 59702

County Silver Bow (Closed)
Facility & # Butte-Silver Bow #20

Closure
Finan Assur
[✓ GW Corr Meas]
GW Monitoring
GW Reports
Inspections
Other:

Landfarm
Liner
Methane
O & M
Run-on

Correspondence Slip

Project ID:
Requested: 5/18/09
Needed By: 5/20/09
Originator: MVP
Org(s)/Mail Code:

REVIEW ROUTING

Name	Task	Initial/Date
Admin	Proof	Jh, 5-18-09
Mary H	Review	meh 5-19
Darrell	Review	das, 5/19
Rick	Review	KT, 5-19-09

Mail original via: ☒ Regular ○ Certified ○ Registered ○ FedEx

Fax to addressee at:

Proof Path: G:\WUT\ see letter

Special Instructions:

Mail copy of enclosures to CC's? Y [✓ N]

Copies of enclosures for file needed? Y [✓ N]

Copy of letter for file needed? [✓ Y] N

Van Oort, Martin

From: Van Oort, Martin
Sent: Monday, April 13, 2009 3:46 PM
To: 'Shawn Bisch'
Cc: 'Brad Archibald'
Subject: RE: Old BSB Landfill Corrective Measures - Extension of Report Due Date

Mr. Bisch,

The Department approves your request for a two week extension for the submittal of the corrective measures effectiveness report for the Closed Butte-Silver Bow Landfill, License #20. The report is now due to the Department by April 29, 2009.

Sincerely,

Martin Van Oort
Environmental Science Specialist (Hydrogeologist)
Solid Waste Program
Montana Department of Environmental Quality
PO Box 200901
Helena, MT 59620-0901
Phone: 406-444-2802
Fax: 406-444-1374

From: Shawn Bisch [mailto:sbisch@pioneer-technical.com]
Sent: Monday, April 13, 2009 3:37 PM
To: Van Oort, Martin
Cc: 'Brad Archibald'
Subject: Old BSB Landfill Corrective Measures - Extension of Report Due Date

Mr. Van Oort,

Thank you for discussing the above referenced report with me. Pioneer Technical Services, Inc. (Pioneer) has completed a *Draft Analysis of the Effectiveness of the Current Corrective Measures at the Old BSB Landfill*; however, as I explained to you on the phone, there are two parties involved with closure of the Old BSB Landfill Facility; and Pioneer has been unable to arrange a meeting with both parties to discuss the contents of the report. As you are aware, the Old BSB Landfill was closed in conjunction with the adjacent Clark Tailings Facility in the mid-1990's. This closure project was administered by both Butte-Silver Bow (Old BSB Landfill) and Atlantic Richfield Company (Clark Tailings/Copper Mountain Sports Complex).

Considering our unsuccessful attempts to arrange a meeting with both parties, we would like to request an extension of the due date of the report from April 15 to April 29, 2009 (two week extension). We will attempt to meet with both parties as soon as possible, and hope to have the report delivered to you prior to April 29.

Thank you for your consideration in this matter.

Shawn Bisch

Pioneer Technical Services, Inc.

307 E. Park Ave., Suite 421

Anaconda, MT 59711

Phone: (406)563-9371

Fax: (406)563-9372

Mobile: (406)498-3923

20

County Silver BoW
Facility & # Old Butte - Closed
Closure
Finan Assur
[✓ GW Corr Meas]
GW Monitoring
GW Reports
Inspections
Other:

Landfarm
Liner
Methane
O & M
Run - On

Memo

To: Joe Griffin
From: Pat Crowley
Date: 4/13/2004
Re: Ground Water at Clark Tails/BSB Landfill

Attached are the latest sample results from the Clark Tailings/Old BSB Landfill area along with a map and the analysis of the selected alternative, Capping and Methane Gas Extraction. I have tabbed the relevant sections on page 9-4 showing estimated times to remediate the site.

The sample results are consistent with what I would expect. The total VOC concentrations at well BSB-A6 have shown a 51% decline since February, 1996. Most notable is the decrease in the polychlorinated solvents and the increase in the degradation product Vinyl chloride. This indicates that few solvents are leaking from the landfill now. Well CLK-2 is showing the expected rise in Zinc and Iron concentration consistent with the dewatering of the tailings. The water coming out of the tailings is a bit more concentrated now that the infiltration has been shut off by the cap. I would expect to start seeing a decrease in the concentrations in another year or so as the tailings finish the dewatering process.

I hope this answers the Councilman's questions. If not, please feel free to contact me. My direct line is 444-5294.

#20

Montana Department of
ENVIRONMENTAL QUALITY
Marc Racicot, Governor
P.O. Box 200901 • Helena, MT 59620-0901 • (406) 444-2544 • E-mail: www.deq.state.mt.us

December 7, 2000

Mr. Gary Keeler
Butte-Silver Bow Landfill
155 West Granite Street
Butte, MT 59701-9256

RE: Replacement well at old landfill (License #20).

Dear Gary,

In examining the latest ground water monitoring results from the Old Butte Landfill on Beef Trail Road (Pioneer Technical Services, November 16, 2000), I noticed that monitoring well BSB-A6, which was abandoned during construction of the Clark Tails Project, has not been replaced. Replacement was supposed to have occurred as soon as the major earthmoving was completed. This is a critical point of compliance well for the corrective measures at the landfill. Without this well it is difficult, if not impossible, to determine the effectiveness of the corrective measures at the facility.

You are hereby required to replace this well by the Spring 2001 sampling event. The well must be sampled for the entire Table 2 list. In order to re-establish the statistical validity of samples from this new well, a minimum of four independent samples must be taken and analyzed for all Table 2 constituents detected during the initial sampling. This should be done as soon as the sampling results are available. (See ARM 17.50.710(1)(a)(V)(D).) This will enable the Department to track the progress of the corrective measures at the landfill from this point forward.

On another topic, VOC samples may be analyzed at the HKM lab as requested in the November 16, 2000 letter.

If I can be of further help in this matter, please feel free to contact me. My direct phone line is 406-444-5294 and my email address is pcrowley@state.mt.us. The Solid Waste Regulatory Program is a part of the Permitting and Compliance Division, Community Services Bureau, Waste Managment Section. Our mailing address is P.O. Box 200901, Helena, MT 59620-0901

Sincerely,

Pat

F. Patrick Crowley
Solid Waste Regulatory Program Manager

cc: Brad Archibald, Pioneer Technical Services, P.O. Box 3445, Butte, MT 59702-3445

File: Silver Bow County/Butte Landfill, License # 20, GW Corrective Measures and GW Correspondence
Path: G:/CSB/Sws/GWater/BSBWellReplacement

County Silver Bow
Facility & # Butte # 20
Closure
Finan Assur
[✓ GW Corr Meas]
GW Monitoring
GW Reports
Inspections
Other:
Landfarm
Liner
Methane
O & M
Run - On
4-3

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COMPLIANCE DIVISION
STE PROGRAM
Metcal
MONTANA
PO Box 200901
Helena, MT 59620-0901

s for the passive methane gas extraction
ill. The system appears to meet standard
The use of PVC piping is acceptable,
painted with a UV inhibitive paint to
o sensitive to cold temperatures and may
n also appears to meet the preferred
ures Assessment and is approved for that
hen the installation is completed so we
tiveness of the selected remedy.

indicates that the placement of the final
and indicates that the January 1996
ld be followed. This plan has been
formation contained in the Final
he Clark Tailings Waste Management
on the test pads and the Hollow borrow
acceptable cap for the landfill. This
Departments telephone comments to
vered in the April 1997 Plan and are
1997 letter giving written approval of

the CQA Plan was intended for both the Old Landfill and the Clark Tailings.

If you have any questions on this matter, please feel free to contact me, my direct line is 406-444-5294. Otherwise, see you in Butte, soon.

Sincerely,

F. Patrick Crowley
Acting Program Manager

cc: Chuck Stillwell, ARCO; Ron Bertram, EPA; Neil Marsh, MDEQ; Brad Archibald, Pioneer.

File:Old Butte Landfill/closure and Corrective Measures files.
Path: CB5403\wp\landfill\closure\butte\methane

Initial

INITIALS_____DATE_____

SOLID WASTE PROGRAM ROUTE SLIP

NEW APPLICATION — Initial / Date
Rick T. ____________
Pat C. ____________
Nancy (Proof) ____________
Cathy ____________
Jon D. ____________

NEW LICENSE — Initial / Date
Rick T. ____________
Pat C. ____________
Nancy (Proof) ____________
Carol ____________
Cathy ____________
Jon D. ____________

HEALTH OFFICER CARD — Initial / Date
Rick T. ____________
Carol ____________
Cathy ____________
______ ____________

INSPECTIONS — Initial / Date
Pat C. ____________
Nancy (Proof) ____________
Carol ____________
Jon D. ____________

INTERIM CLOSURES — Initial / Date
Rick T. ____________
Pat C. ____________
Nancy (Proof) ____________
Carol ____________
Cathy ____________
Jon D. ____________

CLOSURES — Initial / Date
Rick T. ____________
Pat C. ____________
Nancy (Proof) ____________
Carol ____________
Cathy ____________
Jon D. ____________

CHANGE IN LICENSE FOR FEE STATUS — Initial / Date
Rick T. ____________
Pat C. ____________
Nancy (Proof) ____________
Cathy ____________

COMPLAINTS — Initial / Date
Pat C. ____________
Nancy (Proof) ____________
Carol (filing & DBase) ____________

GENERAL CORRESPONDENCE — Initial / Date
Pat C. / Rick T. RPC 4/29
Nancy (Proof) N 4/30
Jon D. (As Needed) JD 4/29

MISCELLANEOUS — Initial / Date
______ ____________
______ ____________
Mailed N 4/30

County Silver Bow
Facility & # Butte # 20

Closure
Finan Assur
✓ GW Corr Meas
GW Monitoring
GW Reports
Inspections
Other:____________

Landfarm
Liner
Methane
O & M
Run - On

\USR\CB5453\WP\FORMS\ROUTE.SW

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COMPLIANCE DIVISION
TE PROGRAM
Metcalf Building

MONTANA

PO Box 200901
Helena, MT 59620-0901

and quality assurance/quality control plans
alf of ARCO and Butte-Silver Bow (BSB) for
Assessment (CMA) and closure of the Old BSB
MA, Landfill Gas Removal with Capping and
rred Remedy. This remedy appears to meet the
ates:

d the environment;
n standard as specified pursuant to (5) of this

s to reduce or eliminate, to the maximum extent
RM 17.50.708] constituents into the
man health or the environment; and
gement of wastes as specified in (8) of this rule.

recognized that the preferred remedy was
resolution or more public input. Items that need

cap and erosion protection layer. The
the surface use has been chosen.

eeds to extend to an elevation corresponding to
iltration through the tailings. Brad Archibald of

Pioneer and I have already discussed this item and he has indicated that the final surface design will incorporate this change.

3) Monitoring well BSB-A6 needs to be properly abandoned according to ARM 17.50.722 and another well completed in approximately the same area once construction is complete. This new well will be the compliance well for the organic compounds from the landfill as has been previously discussed.

4) A copy of the design drawings and QA/QC documents need to be provided to the Helena office of the EPA and to the EPA's construction oversight engineer in Butte.

5) A copy of the "As Built" drawings needs to be supplied to the Department and the Helena office of the EPA upon completion of the construction project.

6) The Department's estimate of the time to demonstrate that the corrective measures selected are working differs from the estimate provided in the CMA. Our modeling indicates that the corrective measures should show environmental improvements in a much shorter time. As with other corrective action projects in Montana, the Department will allow BSB and ARCO the same two year period from the installation of the remedies to demonstrate a positive trend towards compliance with the protection standards. If the trend is not demonstrated within that time, then further measures may be necessary.

The CQA/CQC manual is approved. The testing requirements appear to conform with the appropriate EPA guidance.

I understand that the movement of tailings from Lower Area One to the Clark Tailings is proceeding swiftly. I will stop by soon to view the progress. If you need to discuss any of these items with me, please call. My direct line is 406-444-5294.

Sincerely,

Patrick Crowley

F. Patrick Crowley
Acting Program Manager

4-2

file copy. Silver Bow Co. Butte Landfill #2
G. Water Corr. Meas)

DEPARTMENT OF ENVIRONMENTAL QUALITY
PERMITTING & COMPLIANCE DIVISION
SOLID WASTE PROGRAM
MARC RACICOT, GOVERNOR
Metcalf Building
STATE OF MONTANA
Phone: (406)444-4323
Fax: (406)444-1374
PO Box 200901
Helena, MT 59620-0901

March 21, 1997

Jack Lynch
Chief Executive
Butte-Silver Bow
155 West Granite
Butte, MT 59701

Dear Jack:

We have reviewed the Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment, the public meeting minutes, public comments, comments from Butte-Silver Bow officials and their representatives, and comments and responses from ARCO. It is our conclusion that the Preferred Alternative, Landfill Capping and Passive Gas Venting, is an appropriate remedy.

We understand that the final surface use will be decided after more public input. This will not change the design concepts presented in the Preferred Alternative and we will work with your staff on the design details for whichever uses are proposed. We will also carefully monitor the site during and after construction in order to ensure that there are no adverse impacts to the environment surrounding the facility and that the corrective measures are working.

I would personally like to thank everyone involved in this project for their input and cooperation. Advice from the public and guidance from the Council have been well incorporated with the engineering. Without help from all parties involved, this process would have taken much longer and may not have reached what appears to be a place where everyone wins. Thank you.

Sincerely,

F Patrick Crowley

F. Patrick Crowley
Acting Program Manager

File:Old Butte Landfill Corrective Measures
Path: CB5403\wp\landfill\closure\Butte\CMAOK

Initials FR Date 2/6

SOLID WASTE PROGRAM ROUTE SLIP

☐ **NEW APPLICATION**	**Initial / Date**
Jim W.	
Jon D.	
Proof	
Cathy	
Roger	

☐ **NEW LICENSE**	**Initial / Date**
Jim W.	
Jon D.	
Proof	
Carol	
Cathy	
Roger	

☐ **HEALTH OFFICER CARD**	**Initial / Date**
Jim W.	
Carol	
Cathy	

☐ **INSPECTIONS**	**Initial / Date**
Pat C.	
Jon D.	
Proof	
Carol	
Roger	

☐ **INTERIM CLOSURES**	**Initial / Date**
Jim W.	
Jon D.	
Proof	
Carol	
Cathy	
Roger	

☐ **CLOSURES**	**Initial / Date**
Jim W.	
Jon D.	
Proof	
Carol	
Cathy	
Roger	

☐ **CHANGE IN LICENSE FOR FEE STATUS**	**Initial / Date**
Jim W.	
Jon D.	
Proof	
Cathy	
Roger	

☐ **COMPLAINTS**	**Initial / Date**
Pat C.	
Jon D.	
Proof	
Roger	
Carol (filing & DBase)	

☑ **GENERAL CORRESPONDENCE**	**Initial / Date**
Pat C./Jim W.	FRC
~~Jon D.~~	JD 26
~~Proof~~	
~~Roger~~	

Mail 2-6-96 – Tom

☐ **MISCELLANEOUS**	**Initial / Date**

Old Butte Landfill

DEPARTMENT OF
ENVIRONMENTAL QUALITY

Waste Management Division
Solid Waste Program
406/444-1430

FAX # (406) 444-1499

STATE OF MONTANA

OFFICE LOCATION: 2209 PHOENIX AVE.
HELENA, MONTANA

MAILING ADDRESS: PO BOX 200901
HELENA, MT 59620-0901

February 6, 1996

Jimmy Johnson, Director of Public Works
Butte-Silver Bow Courthouse
155 West Granite
Butte, MT 59701

Dear Jimmy:

I have reviewed the proposed work plan for the Old Butte landfill. I think that this plan will identify the remaining field data gaps so that a final Assessment of Corrective Measures can be done for the landfill.

I will be available during the scheduled field investigation phase to provide on-site technical assistance and approval of changes to the drilling pattern. I have been in contact with Pioneer Engineering (Brad Archibald) and have arranged to meet them on February 7, 1996 at the landfill. I look forward to a productive and informative drilling session.

See you in Butte.

Sincerely,

F Patrick Crowley

F. Patrick Crowley
Solid Waste Regulatory Lead

cc:Brad Archibald, Pioneer

"AN EQUAL OPPORTUNITY EMPLOYER"

ROUTE SLIP

DEPARTMENT OF HEALTH & ENVIRONMENTAL SCIENCES

TO: DATE: June 18, 1995

1. Proof MW

2. Jan JD 6-19

3. Roger pc

☑ Approval
☐ Note and Return
☐ Prepare reply
☐ As requested

☐ Comment
☐ Note and File
☐ Signature
☐ For your information

☐ Necessary Action
☐ Investigate
☐ See Me
☐ Per Conversation

REMARKS:

Reviewed by Jim Wilbur in draft form.

B.SB LF
SBCs closure
Cl II #20

FROM: Pat.

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES

Waste Management Division
Solid Waste Program
406/444-1430

FAX # (406) 444-1902

STATE OF MONTANA

OFFICE LOCATION: 2209 PHOENIX AVE.
HELENA, MONTANA

MAILING ADDRESS: PO BOX 200901
HELENA, MT 59620-0901

June 19, 1995

Jim Johnson
Director of Public Works
Butte-Silver Bow County
155 West Granite
Butte, MT 59701

Dear Jimmy:

I have done a preliminary review of the Draft Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment and have noted a fatal flaw in the analysis: a misinterpretation of the requirements of ARM 16.14.708 (1)(f) and ARM 16.14.704(2)(a) regarding the relevant point of compliance (RPOC) and the violation of the ground water protection standards (GWPS) of ARM 16.14.708(5).

In this document review, the numbering scheme used in the original will be followed for clarity. Since this review is designed as a fatal flaw review, the Department reserves the right to comment on other sections at a later date after a more thorough review.

One initial point should be emphasized. The Department uses the EPA Solid Waste Disposal Facility Criteria, Technical Manual, EPA 530-R-93-017, for guidance on the Federal requirements of Subtitle D of RCRA. Much of the current language in Montana solid waste rules is identical to the language in 40 CFR Part 258 and therefore the EPA guidance is very helpful in evaluating designs to meet current Montana rule requirements.

LANDFILL CLOSURE (Section 4. 1)

ARM 16.14.530, closure requirements for landfills, states:

(1) Closure criteria for Class II landfills are as follows:

(a) Owners or operators of all Class II landfill units must install a final cover system that is designed to minimize infiltration and erosion. The final cover system must be designed and constructed to:

(i) Minimize infiltration through the closed unit by the use of an infiltration layer that contains a minimum 18 inches of earthen material and have a permeability less than or equal to the permeability of any bottom liner, barrier layer, or natural subsoils present, or a permeability no greater than 1 x 10^{-5} cm/sec, whichever is less;

(ii) Minimize erosion of the final cover by the use of a seed bed layer that contains a **minimum of six inches** of earthen material that is capable of sustaining native plant growth **and protecting the infiltration layer from frost effects and rooting damage**; and

(iii) Revegetate the final cover with native plant growth within one year of placement of the final cover. The department may approve alternative revegetation plant species or an extension in the time requirement for revegetation.

(b) The department may approve an alternative final cover design that includes:

(i) An infiltration layer that achieves reduction in infiltration at least equivalent to the infiltration layer specified in (1)(a)(i) and (ii) of this rule; and

(ii) An erosion layer that provides protection from **wind and water erosion** equivalent to the erosion layer specified in (1)(a)(iii) and (vi) of this rule. (Emphasis added.)

Will the proposed design meet these requirements? Please refer to page 322 and following of the EPA Solid Waste Disposal Facility Criteria, Technical Manual, EPA 530-R-93-017, for guidance on final cover design.

ARM 16.14.506 sets requirements for the quality control and quality assurance required for landfill capping.

> (12) Verification of construction of the final cap, liner, and leachate collection and removal system approved by the department is required by means of construction quality control (CQC) and construction quality assurance (CQA) plans and testing for construction of these elements of design in accordance with submitted specifications.
>
> (13) CQC and CQA plans must be approved by the department.
>
> (14) A report of all CQC and CQA procedures and results of all testing and monitoring provisions performed during construction of the design features for a landfill unit as specified in the approved plans must be submitted to the department and approved in writing before acceptance of waste by a landfill unit is allowed.

These plans must be submitted to the Department for review and approval. This includes all areas which received waste after October 9, 1991. The Department has received no CQA\CQC plans or reports for the work done to date.

GROUND WATER PROTECTION STANDARDS (Section 4.2)

According to ARM 16.14.708:

> (5) The ground water protection standard (enforcement standard) for each Table 1 and Table 2 (ARM 16.14.706) constituent must be:
>
> (a) For constituents for which a maximum contaminant level (MCL) has been promulgated under the Montana ground water quality standards, the MCL for that constituent;
>
> (b) For constituents for which MCLs have not been promulgated, the background concentration for the constituent established from wells in accordance with ARM 16.14.706;
>
> (c) For constituents for which the background level is higher than the MCL identified under (5)(a) of this rule or health based levels identified under 5(d) of this rule, the background concentration; or
>
> (d) The department may establish alternative ground water protection standards (enforcement standards) for which MCLs have not been established based on the following criteria:
>
> (i) The level is derived in a manner consistent with U.S. EPA guidelines for assessing the health risks of environmental pollutants (51 FR 33992, 34006, 34014, 34028, September 24, 1986);
>
> (ii) The level is based on scientifically valid studies conducted in accordance with the Toxic Substances Control Act Good Laboratory Practice Standards (40 CFR, Part 792) or equivalent;
>
> (iii) For carcinogens, the level represents a concentration associated with an excess lifetime cancer risk level (due to continuous lifetime exposure) with the 1×10^{-4} to 1×10^{-6} range; and
>
> (iv) For systemic toxicants, the level represents a concentration to which the human population could be exposed to on a daily basis that is likely to be without appreciable risk of deleterious effects during a lifetime. For purposes of this subsection, systemic toxicants include toxic chemicals that cause effects other than cancer or mutation.

The Human Health Standards (HHS) found in WQB-7 meet the requirements of ARM 16.14.708(5)(d) for alternative ground water protection standards. Therefore, if there is an MCL, the GWPS is the MCL. If there is no MCL, but there is a WQB-7 HHS, then the WQB-7 value is the GWPS. If neither of the previous two apply, then background values are the GWPS.

RELEVANT POINT OF COMPLIANCE

According to ARM 16.14.704(2):

> Downgradient groundwater quality monitoring wells must be capable of detecting a migration of hazardous constituents from active and closed waste disposal areas. The number and location of downgradient monitoring wells must be approved in writing by the department. At least two downgradient monitoring wells are required, although the department may require more.
>
> (a) The downgradient monitoring system must be installed at the relevant point of compliance specified by the department that ensures detection of ground water contamination in the uppermost aquifer.

The down gradient ground water monitoring wells at the landfill are, in accordance with ARM 16.14.704(2)(a), located at the RPOC. These wells are in exceedance of the GWPS, and a corrective measure that meets the requirements of ARM 16.14.708(7)(b)(ii) must be initiated.

STATISTICAL EVALUATION

In addition to the point of compliance problems previously identified, there also appears to be some confusion over the statistical testing required in ARM 16.14.706(12) and (13), particularly with the requirements of ARM 16.14.706(13)(e), data below the limit of detection. A common confusion at landfills is between the method detection limit (MDL) and the practical quantitation limit (PQL). The PQL is normally ten times the MDL and both are lab and matrix specific. ARM 16.14.706(13)(e) also requires that the lowest PQL **"available to the facility"** be used to prevent shopping for a lab with high PQLs. The values listed in Table 2 of ARM 16.14.706 are a general estimate for the methods and compounds listed and are not a part of the regulation. To quote from the footnotes to Table 2 of ARM 16.14.706:

> 6. Practical Quantitation Limits (PQLs) are the lowest concentrations of analytes in ground waters that can be reliably determined within specified limits of precision and accuracy by the indicated methods under routine laboratory operating conditions. The PQLs listed are generally stated to one significant figure. PQLs are based on 5 mL samples for volatile organics and 1 L samples for semivolatile organics. CAUTION: The PQL values in many cases are based only on a general estimate for the method and not on a determination for individual compounds; PQLs are not a part of the regulation.

Most labs achieve better values than the ones in Table 2 due to improvements in instrumentation since the rules were written. For example: Energy Lab's normal PQL for 8260 compounds is 1 ppb, compared to the 5 ppb listed in Table 2. If a sample is contaminated and must be diluted, the PQL will be correspondingly higher according to their brochure.

Most labs report values between the MDL and PQL with a flagged value of some kind, like the "J" values of Energy Labs. The Department routinely treats "U", "ND" or "not detected" values, as one-half the MDL, not the PQL. "J" values, if assigned a number, use the number assigned with a realization of the accuracy. If no value is assigned by the lab to detections between the MDL and PQL, a value of one-half the PQL is often used for statistical purposes. These procedures are consistent with the guidance provided by the EPA in their 1989 and 1992 papers on statistics at RCRA facilities. The Department encourages facilities to quantify concentrations below the PQLs for their own knowledge, and also for simplifying usage in statistics.

The use of this approach would change the discussion related to bis(2-ethylhexyl)phthalate, and the values used in the statistical analysis. Once these values are revised, the statistical test methods, calculations, and conclusions must be presented to the Department as per the requirements of ARM 16.14.521(1)(q).

CONTAMINANT ASSESSMENT AND CONCEPTUAL SITE MODEL

This section (Section 5.0) does not assess the volume of contaminants, the flow rate/rate of transport, contaminant attenuation, contributions from the Clark Tailings, and several other pertinent factors relating to the ground water contamination at the landfill. Most of these data gaps should be filled as suggested in Section 8. A plan to complete the information needed should be presented to the Department for approval as required by ARM 16.14.716(1).

DEVELOPMENT AND SCREENING OF ALTERNATIVES

This section (Section 6.0) is flawed because of point of compliance and protection standards problems previously mentioned. This section must be re-written to include treatment of ground water contamination from the landfill to meet the GWPS at the RPOC. Numerous potential methods are listed in the U.S. EPA's publication Subsurface Remediation Guidance, EPA\540\2-90\011a; however, the Department will evaluate whichever method(s) are proposed.

REMEDY REQUIREMENTS

ARM 16.14.708(7)(b) states:

> Remedies must:
> (i) Be protective of human health and the environment;
> (ii) Attain the ground water protection standard as specified pursuant to (5) of this rule;
> (iii) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent practicable, further releases of Table 2 (ARM 16.14.706) constituents into the environment that may pose a threat to human health or the environment; and
> (iv) Comply with standards for management of wastes as specified in (8) of this rule.
> (v) Be approved by the department.

The capping measures proposed can be considered as a component of the contaminant release control required by ARM 16.14.708(7)(b)(iii), but the current study has not demonstrated that capping alone with the proposed design, in an unlined landfill, can attain the GWPS required.

The Department will not accept the exclusion of potential remedies (for example multi-media capping) because of higher, but not prohibitive, cost estimates. Costs are only one factor in the evaluation required in ARM 16.14.708(7)(c).

Two specific alternatives that should be considered are: 1) the capping of the entire landfill to 1993 standards and 2) the capping of the landfill only, rather than the landfill and Clark Tailings, to a higher degree of protection with a multi-media or lower permeability cap.

SUMMARY

According to the evaluation above, the following sections of the report need revision: parts of the Executive Summary; Sections 4.2, Groundwater Protection Standards; 5.0, Contaminant Assessment and Conceptual Site Model (whole section); 6.0, Development of Screening Alternatives (additional information required on ground water remediation); 7.0, Interim Measures Analysis; 8.1, Continued Groundwater Monitoring (see ARM 16.14.708(6)(b)); 12.0 Project Schedule.

Section 8 plans to fill data gaps require Department approval and should be submitted as soon as possible.

Additional review of the draft document is being performed by the Environmental Remediation Division. Their comments will also be provided shortly.

I have two final editorial notes: the yellow lines on the figures (see 2-3 and 2-5) are impossible to read. Please choose another color. Metric and English measurements should not be mixed on figures and contour intervals and distances should be presented as a uniform datum. The Department has no preference as to which is used, however EPA requirements for data presentation with regards to measurement preference may differ and should be followed.

We are hopeful that a prompt response is available for these requirements. Pending the preparation of the final document, the Department is willing to approve interim measures at the Old Butte-Silver Bow Landfill regarding the planned capping of the landfill. We realize the short length of the construction season in Montana, and do not want to cause any delays in the project. Please feel free to contact me on any of these topics.

Sincerely,

F Patrick Crowley

F. Patrick Crowley
Solid Waste Regulatory Lead

cc: Pioneer Technical Services, P.O. Box 3445, Butte, MT 59702
Jim Scott, ERD Superfund
Sara Weinstock, EPA, Butte office
EPA, Helena office.

File:Old Butte L.F.\closure file
Path:H:\cb5403\wp\landfill\grndwatr\butte\buttecma.619

File Copy:
Silver Bow Co,
"old" Butte II
closed,
grd wtr (corr)

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES
Waste Management Division
Solid Waste Program
406/444-1430

FAX # (406) 444-1499

STATE OF MONTANA

OFFICE LOCATION: 2209 PHOENIX AVE. HELENA, MONTANA

MAILING ADDRESS: PO BOX 200901 HELENA, MT 59620-0901

July 20, 1994

Jim Johnston, Director of Public Works
Department of Public Works
155 West Granite Street
Butte, Montana 59701

RE: **BUTTE-SILVER BOW CLASS II LANDFILL, SILVER BOW COUNTY - LICENSE NO. 20**
GROUND WATER - CORRECTIVE MEASURES

Dear Mr. Johnston:

A facility facing ground water corrective measures activities should carefully evaluate the quality and quantity of the hydrogeologic information; and specifically, the ground water (hydrologic) data that has been accumulated to date at the site, to determine:

1. If the entire active and inactive licensed disposal areas have been adequately investigated and a sufficient number of borings and monitoring wells have been installed at the site;

2. If pre-existing data sources in the area have been investigated and evaluated, such as aerial photos, geophysical surveys, stratigraphic boreholes, piezometers, head measurements, in-situ hydraulic conductivity tests, and/or laboratory analyses of ground water samples or surface water samples collected in the area;

3. If the data from the site is consistent, or are there trend(s) or gaps in the data;

    a. Is the hydrogeology similar across the site? More complex sites require more borings, wells, etc.

    b. Are the ground water analytical results repeatable and consistent over time (at least 2 to 4 years)?

    c. Have sufficient samples been taken to provide a statistical basis for comparison?

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4. Whether the contamination found in the ground water is confined to a hot spot or margin beneath the facility property, and/or beneath an adjacent property;

5. If the contamination in the ground water has migrated off-site;

6. What are the parameters/constituents of concern (i.e., driver constituents). How high are the concentrations of these constituents in the ground water? Have maximum contaminant levels (MCLs) been established for these constituents? Are they carcinogens, or toxins?

7. Is the aquifer presently being monitored a drinking water source, locally or regionally? If so, where are the receptors located in relation to the landfill site? If not, how close is the ground water-bearing zone(s) or aquifer(s) presently being monitored at the facility to a drinking water aquifer or supply source, geologically (i.e., separation in depth from ground surface to aquifer, vertically downward).

From the above information:

What are the risks to human health and the environment?

Could an alternate ground water protection standard be determined that is protective of human health and the environment?

What methods of remediation can reduce the known contaminant concentrations in the ground water sufficiently to meet the established ground water protection standards and/or background concentrations, and what are the economics associated with the proposed remedial measures?

If a potential hazard to the public is proven to be negligible, a costly program of remediation may be demonstrated to be unnecessary in some cases. If there is a potential that the public health could be significantly endangered at a site, a risk assessment (RA) must be employed to determine the appropriate levels of clean-up required to bring the risks within acceptable levels. Hazardous substance health risks can be categorized into two primary concerns:

a. The inherent toxicity of the contaminant, and

b. The degree of exposure experienced by the public.

Has this facility already initiated the required upgrades to the operational procedures which may also address in-part the corrective measures remedies? Some of the operational requirements that have already been observed to help improve the quality of the ground water at an impacted landfill site are:

I. The installation of a low permeability cover/cap over the inactive/closed disposal areas to reduce/eliminate infiltration of surface water/precipitation into the waste;

II. Establish a vegetative layer over the cover/cap to help eliminate runoff, and reduce infiltration; and

III. Install a passive and/or active gas venting system, as determined from methane monitoring results at the facility.

If your facility has implemented some or all of these upgrades, have you seen reduced concentrations of contaminants in the ground water? At what rate, since the above actions/measures were implemented?

The Department requires an adequate and accurate site characterization of the soils and hydrogeology be provided at each site; however, some facilities may be in a situation where natural geologic and hydrologic complexities compound the ground water contamination problem already known to exist at the site. Source removal, and/or reduction, is generally not a feasible solution. Stabilization or containment may abate problems posed by contaminant migration in the ground water. Most sites with ground water contamination must look at long-term operations and objectives, with present and potential risks to human health and the environment factored into any proposed remediation effort. It is important to understand the conditions of the ground water at the facility, the associated risks to human health and the environment, and the economically and technologically feasible approaches available under the known/existing conditions at the site.

The enclosed summary of the corrective measures portion of the ARM 16.14.708 regulation will hopefully be more user-friendly than the regulations themselves. Note that this summary is organized in a more orderly, successive series of events. Regulatory citations are provided for your reference.

Sincerely,

Pat Potts

Pat Potts
Environmental Specialist

cc: Gary Keeler, Department of Public Works, Courthouse, Butte, MT 59701

Marcus Murphy, and David S. Tuesday, Pioneer Technical Services, Inc., P.O. Box 3445, Butte, MT 59702

ASSESSMENT MONITORING RESULTS

After a solid waste facility has initiated the Assessment Ground Water Monitoring Phase [initial sampling according to Table 2 (ARM 16.14.706], due to parameter/constituent exceedences equal to or above an enforcement standard/ground water protection standard (MCLs), or when concentrations which are shown to be statistically significant over background (within the required 90-day period following this exceedence discovery), one of the following circumstances will become apparent from the site-specific analytical results of the Table 2 sampling:

> 708(2) Concentrations of all Table 2* constituents are at or statistically below background values for 2 consecutive sampling events;
>
> 708(3) Concentrations of any Table 2* constituents are statistically above background values, but all concentrations are below the ground water protection standards (MCLs)/enforcement standards; or
>
> 708(4) Concentrations of one or more Table 2* constituents are detected at statistically significant levels above the ground water protection standards (MCLs)/enforcement standards.

If 708(2), then the facility may return to Detection Monitoring (i.e., sampling for Table 1 [ARM 16.14.706]).

If 708(3), then the facility will remain/continue in Assessment Monitoring.

* Refers to both Table 1 and Table 2 (ARM 16.14.706) parameters/constituents, as Table 2 is inclusive of most parameters/constituents on Table 1.

CORRECTIVE MEASURES ASSESSMENT (CMA)

However, if 708(4) is true and an exceedence has occurred, then the facility is required to:

16.14.708(4)(a)(i)	Install additional monitoring wells, as needed, to characterize the nature and extent of the release,
708(4)(a)(ii)	Install at least 1 additional monitoring well at the hydraulically down gradient facility property boundary,
708(4)(a)(iii)	Notify all persons who own the land or reside on the land that directly overlies the plume, and
708(4)(a)(iv)	Initiate an "assessment of corrective measures", within 90 days from the discovery/receipt of the analytical results from the Table 2 ground water analysis (i.e., the initial Assessment Monitoring event). The assessment is to be completed within an additional 60 days (i.e., 150 days total time allowed for assessment of corrective measures, from the date of the receipt of the analytical results from the initial Table 2 sampling event) for submittal to the Department [ARM 16.14.708(6)(a)].

The Corrective Measures Assessment (CMA) is Required to Include the Following:

16.14.708(6)(c)	Analysis of the effectiveness of potential corrective measures, (Requirements and objectives of each remedy under consideration.)

708(6)(c)(i) For each remedy proposed, evaluate the following:

- Performance
- Reliability
- Ease of implementation
- Potential impacts - safety,
  - cross-media,
  - control exposure to any residual contamination.

708(6)(c)(ii) Time-frames - initiate remedy (i.e., operational)
estimated completion of remedy

708(6)(c)(iii) Costs - based on site-specific contaminants, concentrations, and media volumes.

708(6)(c)(iv) Additional requirements - State and/or local permit requirements, or other environmental or public health requirements that may affect implementation of each remedy suggested.

A report will be required by the Department addressing all of the above issues for each remedy considered [ARM 16.14.716(1)].

708(6)(d) The results arrived at from the CMA are required to be discussed in a PUBLIC MEETING with interested and affected parties prior to final remedy selection.

CORRECTIVE MEASURES REMEDY SELECTION

From the results of the corrective measures assessment (CMA) and the accompanying report submittal to the Department, the owner/operator is required to select a remedy based on the results of the CMA, and to notify the Department within at least 14 days from the date of the selection. This remedy must meet the following standards [ARM 16.14.708(7)(a)]:

708(7)(b)(i)	Protective of human health and the environment,
708(7)(b)(ii)	Attain the ground water protection standard, or the alternate ground water protection standard,
708(7)(b)(iii)	Control source(s) - reduce or eliminate releases,
708(7)(b)(iv)	Comply with the "Standards for Management of Wastes", which requires a schedule for "Initiating and Completing Remedial Activities". The schedule should consider the following factors:
708(7)(d)	Schedule - "Initiating and completing remedial activities" should consider the following factors:
708(7)(d)(i)	Extent and nature of contamination,
708(7)(d)(ii)	Practical capabilities of remedial technologies in achieving compliance with ground water protection standards,
708(7)(d)(iii)	Treatment or disposal capacity for wastes,
708(7)(d)(iv)	Utilization of unavailable technologies (i.e., future technologies), and

708(7)(d)(v)	Risks to human health and the environment:
708(7)(d)(vi)	Resource value of the aquifer,
708(7)(d)(vi)(A)	Current and future uses,
708(7)(d)(vi)(B)	Proximity and withdrawal rate of users,
708(7)(d)(vi)(C)	Ground water quantity and quality,
708(7)(d)(vi)(D)	Potential damage due to exposure to wildlife, crops, vegetation, and physical structures,
708(7)(d)(vi)(E)	Hydrogeologic characteristic of the facility and the surrounding land,
708(7)(d)(vi)(F)	Ground water removal and treatment costs, and
708(7)(d)(vi)(G)	Cost and availability of alternate water supplies.
708(7)(d)(vii)	Practical capability of the owner/operator.
708(7)(d)(viii)	Other relevant factors.
708(8)(a)	The schedule for "Initiating and Completing Remedial Activities" requires the owner/operator to provide:
708(8)(a)(i)	Corrective action ground water monitoring program:
708(8)(a)(i)(A)	At least as inclusive as the Assessment Monitoring program,
708(8)(a)(i)(B)	Demonstrates the effectiveness of the corrective action remedy, and

708(8)(a)(i)(C)	Demonstrates compliance with the ground water protection standards.
708(8)(a)(ii)	Implementation of corrective action remedy selected.
708(8)(a)(iii)	Possible interim measures to ensure the protection of human health and the environment.
708(8)(b)	Evaluation of compliance achieved (or not achieved) through the remedy selected. If not, owner/operator is required to select another remedy or technique, OR
708(8)(c)	Determine that compliance cannot be practically achieved with any currently available methods by:
708(8)(c)(i)	Obtain certification from a qualified ground water scientist and approval by the Department that compliance cannot be achieved,
708(8)(c)(ii)	Implement alternative measures to control exposure, and protect human health and the environment,
708(8)(c)(iii)	Implement alternative measures for the control of sources of contamination, etc. as is:
708(8)(c)(iii)(A)	Technically practicable,
708(8)(c)(iii)(B)	Consistent with remedial objective(s), and

708(8)(c)(iv) Submit a report to the Department 14 days prior to the implementation of the alternative measures. This report should include an evaluation of all remedies considered, as well as the NO ACTION alternative [ARM 16.14.716(1)] if this information has not been thoroughly addressed in the CMA report.

708(7)(b)(v) Approved by the Department.

708(7)(c) Remedy(ies) "evaluation factors":

708(7)(c)(i) Effectiveness and protectiveness (short- and long-term), as well as the degree of certainty that the remedy(ies) will be successful considering:

708(7)(c)(i)(A) Magnitude of reduction of existing risk,

708(7)(c)(i)(B) Magnitude of residual risks,

708(7)(c)(i)(C) Long-term management required (monitoring, operation, and maintenance,

708(7)(c)(i)(D) Short-term risks (community, workers, or the environment),

708(7)(c)(i)(E) Time until full protection achieved,

708(7)(c)(i)(F) Potential for exposure (human and environmental),

708(7)(c)(i)(G) Long-term reliability, and

708(7)(c)(i)(H) Potential need for replacement of the remedy.

708(7)(c)(ii)	Effectiveness of the remedy in controlling the source based on the following factors:
708(7)(c)(ii)(A)	Containment practices usage, and
708(7)(c)(ii)(B)	Treatment technology use.
708(7)(c)(iii)	Implementation of a potential remedy(ies) - ease or difficulty.
708(7)(c)(iii)(A)	Construction technology,
708(7)(c)(iii)(B)	Operational reliability,
708(7)(c)(iii)(C)	Approvals and permits from other agencies,
708(7)(c)(iii)(D)	Availability of equipment and specialists, and
708(7)(c)(iii)(E)	Available capacity and location of needed treatment.
708(7)(c)(iv)	Technical and economic capability of the owner/operator.
708(7)(c)(v)	Address community concerns with relation to potential remedy(ies).
708(7)(e)	The Department may determine that remediation of a release is not necessary if the owner/operator demonstrates that:
708(7)(e)(i)	There is additional contamination of the ground water from a source other than the landfill, and clean-up of the landfill associated contamination would not reduce risks to actual or potential receptors, OR

708(7)(e)(ii)	The ground water is:
708(7)(e)(ii)(A)	Not currently or reasonably expected to be a source of drinking water, and
708(7)(e)(ii)(B)	Not hydraulically connected, or will not migrate in concentrations exceeding the ground water protection standards, OR
708(7)(e)(iii)	Remediation is technically impractical, OR
708(7)(e)(iv)	Remediation results in unacceptable cross-media impacts.
708(7)(f)	The State will still maintain the authority to require the owner/operator to undertake source control measures or other measures to eliminate or minimize further releases to the ground water, to prevent exposure to the ground water, or to remediate the ground water to concentrations that are technically practical and significantly reduce threats to human health and the environment.

PIONEER
TECHNICAL SERVICES, INC.

RECEIVED
NOV 13 2017
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

November 10, 2017

Mr. John Collins
Montana DEQ/Solid Waste Program
P.O. Box 200901
Helena, Montana 59620-0901

#20

RE: Old Butte-Silver Bow County Landfill/Clark Tailings

Dear John:

Enclosed are the results from the Old Butte-Silver Bow County Landfill/Clark Tailings September 2017 semi-annual groundwater monitoring event. The following have been included for your information:

- September 2017 Groundwater Monitoring Summary.
- Table 1: Analytical Data Summary.
- Statistical analysis (non-parametric comparison of wells) (included electronically with this letter).
- Groundwater parameters collected in the field.
- Copy of field notes.
- Trend graphs of detected compounds.
- Figure 1: Groundwater Flow Map for September 2017.
- Analytical results from Pace Analytical Services, LLC located in Minneapolis, Minnesota (included electronically with this letter).

Pioneer has calculated a confidence level of 98.0 % per the formula [n/(n+k)] established by the *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities Addendum to Interim Final Guidance* (EPA, 1992).

The groundwater and seepage velocities were calculated using Darcy's Law. The average groundwater velocity for the September 2017 sampling event was 0.296 feet per day (ft/day). The hydraulic conductivity value (2.83 ft/day) used to calculate the groundwater velocity was obtained from the *Corrective Measures Assessment Report* (Pioneer, 2009) and from the March 2009 pumping data.

Sincerely,

Joseph S McElroy

Joseph S. McElroy, P.E.
Project Manager

HEADQUARTERS: PO BOX 3445 • BUTTE, MT 59702 | PH: 406.782.5177 • FX: 406.782.5866 | WWW.PIONEER-TECHNICAL.COM
ANACONDA • BILLINGS • BOZEMAN • HELENA • MISSOULA • EVANSTON, WY • KELLOGG, ID

Encl.

cc. Dave Schultz, BSB Public Works Director
Glen Rafish, BSB Landfill Manager
Eric Hassler, BSB Health Department, 25 W. Front Street, Butte, MT 59701
Brandon Warner, BSB Health Department, 25 W. Front Street, Butte, MT 59701
Loren Burmeister, Atlantic Richfield (email)
Cord Harris, Atlantic Richfield (email)
Irene Montero, Atlantic Richfield (email)
70.04.25.16 – MiningSharePoint@bp.com

OLD SILVER BOW LANDFILL
SEPTEMBER 2017 GROUNDWATER MONITORING

The September 2017 sampling event at the Old Butte-Silver Bow Landfill included sampling according to the modified assessment-monitoring program. The attached Table 1 summarizes the analytical results. The discussion below compares the September 2017 results to previous results, current Maximum Contaminant Levels (MCLs), and the Montana Human Health Standards (HHSs).

Well MBMG-2 (Upgradient):

In accordance with the modified assessment-monitoring program, semi-volatiles, chlorinated acids, and pesticides were not collected in this well during the September 2017 sampling event.

Metals that were detected below the maximum background concentrations include: antimony (Sb) (0.00024 J milligrams per Liter [mg/L]), arsenic (As) (0.0013 mg/L), barium (Ba) (0.142 mg/L), cadmium (Cd) (0.00008 mg/L), chromium (Cr) (0.00032 J mg/L), cobalt (Co) (0.00022 J mg/L), copper (Cu) (0.0012 mg/L), iron (Fe) (0.0076 J mg/L), nickel (Ni) (0.00014 J mg/L), selenium (Se) (0.00071 mg/l), vanadium (V) (0.0073 mg/l), and zinc (Zn) (0.0048 J mg/L). There were no metals detected above the maximum background concentrations during this sampling event.

No volatile organic compounds (VOCs) were detected in well MBMG-2 during the September 2017 sampling event.

Nitrate/nitrite (1.90 mg/L), chloride (59.8 mg/l), and sulfate (138 mg/L) were detected at concentrations below the maximum background.

No MCL or HHS exceedances were observed in well MBMG-2 during the September 2017 sampling event.

Well BSB-A1 (North Well):

In accordance with the modified assessment-monitoring program, semi-volatile, chlorinated acids, pesticides, and a sample for metals analyses were not collected from well BSB-A1 during the September 2017 sampling event.

No VOCs were detected in well BSB-A1 during the September 2017 sampling event.

Potential of hydrogen (pH) (7.9) exceeded the maximum baseline concentration for well BSB-A1.

No MCL or HHS exceedances were observed in well BSB-A1 during the September 2017 sampling event.

Well BSB-A5 (Northeast Well):

In accordance with the modified assessment-monitoring program, semi-volatile, chlorinated acids, pesticides, and a sample for metals analyses were not collected from well BSB-A5 during the September 2017 sampling event.

Levels of cis-1,2-Dichloroethene (2.3 micrograms per Liter [µg/L]) were detected above the maximum background concentration.

During the September 2017 sampling event, the following VOCs were also detected, but at concentrations below the maximum baseline and background:

- Tetrachloroethene (0.85 J µg/L).
- Trichloroethene (0.47 µg/L).

Specific conductance (1,640 micromhos per centimeter [umhos/cm]) and sulfate (711 mg/L) were detected above the maximum background concentration.

Results from the September 2017 sampling event also show that the level of sulfate (711 mg/L) exceeded the current MCL of 250 mg/L.

Well BSB-A6-R (Central Well):

Well BSB-A6-R is the replacement well for BSB-A6, which was removed during construction of the Timber Butte Youth Park.

In accordance with the modified assessment-monitoring program, semi-volatile, chlorinated acids, pesticides, and a sample for metals analyses were not collected from well BSB-A6-R during the September 2017 sampling event.

The following seven VOCs were detected in well BSB-A6-R during the September 2017 sampling event:

- Benzene (0.47 J µg/L).
- 1,4-Dichlorobenzene (1.0 µg/L).
- Dichlorodifluoromethane (1.2 µg/L); exceeds the maximum background concentration.
- 1,1-Dichloroethane (1.3 µg/L); exceeds the maximum background concentration.
- cis-1,2-Dichloroethene (3.6 µg/L); exceeds the maximum background concentration.
- Tetrachloroethene (0.28 J µg/L).
- Vinyl chloride (1.1 µg/L); exceeds the maximum background concentration.

Four of the seven VOCs listed above were detected at levels above the maximum background concentration. Vinyl chloride (1.1 µg/L) also exceeded the HHS of 0.2 µg/L.

Sulfate (1,500 mg/L), specific conductance (2,680 umhos/cm), cyanide (0.0163 mg/L) and chemical oxygen demand (388 mg/L) exceeded the maximum background concentration. The pH (6.7) exceeded the maximum baseline concentration (6.5) for well BSB-A6-R.

Results from the September 2017 sampling event also show that the level of sulfate (1,500 mg/L) exceeded the current MCL of 250 mg/L.

Well CLK-1 (Clark Tailings East Well):

In accordance with the modified assessment-monitoring program, no samples for VOCs analyses were collected from well CLK-1 during the September 2017 sampling event.

Metals detected above the maximum background concentration, but below the maximum baseline concentration include: As (0.0837 mg/L), Cd (0.0111 mg/L), Co (0.0344 mg/L), Fe (9.77 mg/L), Ni (0.0306 mg/L), and Zn (40.4 mg/L). Arsenic, Cd, Fe, and Zn exceeded the current MCLs and HHSs.

The levels of sulfate (648 mg/L) and specific conductance (1,490 umhos/cm) exceeded the maximum background concentrations. The level of sulfate was also higher than the current MCL for this compound (250 mg/L).

The pH for well CLK-1 (7.1) was also higher than the maximum baseline concentration (6.5).

Well CLK-2 (Clark Tailings North Well):

In accordance with the modified assessment-monitoring program, no samples for VOCs analyses were collected from well CLK-2 during the September 2017 sampling event.

The following metals were detected above the maximum background concentrations: Cd (0.0013 mg/L), Ni (0.0502 mg/L), and Zn (0.71 mg/L).

The levels of sulfate (710 mg/L) and specific conductance (1,610 umhos/cm) exceeded the maximum background concentrations. The level of sulfate was also higher than the current MCL for this compound (250 mg/L).

Conclusion:

The September 2017 sampling event at the Old Butte-Silver Bow Landfill included sampling according to the modified assessment-monitoring program. Please refer to Table 1 for a summary of the analytical data. The results for metals, inorganics, and organic contaminants obtained from the September 2017 sampling event were comparable to previous sampling event results at the Old Butte-Silver Bow Landfill.

SAMPLE NUMBER WELL ANALYTE (units):	BSB-GW-01 MBMG-2	BSB-GV BSB-/	BSB-GW-09 Field Blank Trip Blank	GW PROTECTION STANDARDS USEPA MCL*	 MONTANA HHS
DISSOLVED METALS (mg/L)					
Antimony	(Pace 0.0024 J)< 0.0005	5	< 0.0005	0.006	0.014
Arsenic	0.0013	8	< 0.0005	0.05	0.01
Barium	0.142	8	< 0.0003	2	2
Beryllium	< 0.0002	47	< 0.0002	0.004	0.004
Cadmium	< 0.00008	2	< 0.00008	0.005	0.005
Chromium	(Pace 0.00032 J)< 0.0005	5	< 0.0005	0.1	0.1
Cobalt	(Pace 0.00022 J)< 0.0005		< 0.0005	---	---
Copper	0.0012		0.0157	1.3 (a)	1.3
Iron	(Pace 0.0076 J) < 0.0500		< 0.05	0.3(s)	0.3
Lead	< 0.00010	1	(Pace 0.000045)< 0.0001	0.015 (a)	0.015
Mercury	NR		NR	0.002	0.002
Nickel	(Pace 0.00014 J)< 0.00050	8	< 0.0005	0.1	0.1
Selenium	0.00071	5	< 0.0005	0.05	0.05
Silver	NR		NR	0.1	0.1
Thallium	NR		NR	0.002	0.002
Tin	NR		NR		
Vanadium	0.0073		< 0.001	---	---
Zinc	(Pace 0.0048 J)< 0.0050		(Pace 0.0018 J)< 0.005	5	2
INORGANICS (mg/L)					
Chloride	59.8		< 1.0	250	---
COD	< 50.0		NR	---	---
Conductivity (umhos/cm)	853		2.9	---	---
Cyanide	(Pace 0.0054 J)< 0.010	(Pace 0.0047 J)>	NR	---	0.2
Nitrate\Nitrite - N	1.9		NR	10	10
pH	7.9		5.8		
Sulfate	138		2.8	250	---
Sulfide	SA		NR		
EPA METHOD 8260 (ug/L)					
Acetone	< 20.0	<	SA	---	---
Benzene	< 1.0	<	SA	5	5
Carbon Disulfide	< 1.0	<	SA	---	---
Chloroethane	< 1.0	<	SA	---	---
Chloroform	< 1.0	<	SA	---	70
Chlormethane	< 4.0	<	SA	---	---
1,4-Dichlorobenzene	< 1.0	<	SA	75	75
Dichlorodiflouromethane	< 1.0	<	SA	---	1000
1,1-Dichloroethane	< 1.0	<	SA	---	---
1,2-Dichloroethane	< 1.0	<	SA	5	4
cis-1,2-Dichloroethene	< 1.0	<	SA	70	70
trans-1,2-Dichloroethene	< 1.0	<	SA	100	100
Ethylbenzene	< 1.0	<	SA		
1,2-Dichloropropane	< 4.0	<	SA	5	5
4-Isopropyltoluene	NR		SA	---	---
Methylene Chloride	< 4.0	<	SA	5	30
Naphthalene	NR		SA	---	100
Tetrachloroethene	< 1.0	<	SA	5	5
Trichloroethene	< 0.4	<	SA	5	5
1,2,4-Trimethylbenzene	NR		SA	---	---
Vinyl Chloride	< 0.2	<	SA	2	0.2
EPA METHOD 8270 (ug/L)					
bis(2-ethylhexyl)Phthalate	SA		SA	6	6
EPA METHOD 8151 (ug/L)					
Picloram	SA		SA		
Dicamba	SA		SA		
2,4,5-TP (Silvex)	SA		SA		
2,4-D	SA		SA		
EPA METHOD 8081 (ug/L)					
	SA		SA		
EPA METHOD 8082 (ug/L)					
	SA		SA		

* MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
NA = Not enough sample available for analysis
NR = Analysis Not Requested
ND = Analyte Not Detected
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
NS= Sample Not Collected
SA = Sample Not Taken

TABLE I: ANALYTICAL DATA FOR GROUNDWATER SAMPLES, OLD SILVER BOW COUNTY LANDFILl
DATE SAMPLED: September 20 & 21, 2017

SAMPLE NUMBER	BSB-GW-01	BSB-GW-02	BSB-GW-03	BSB-GW-04	BSB-GW-05	BSB-GW-06	BSB-GW-07	BSB-GW-08	BSB-GW-09	GW PROTECTION STANDARDS	
WELL	MBMG-2	BSB-A1	BSB-A5	BSB-A6-R	CLK-1	CLK-2	BSB-A6R DUPE	CLK-1 DUPE	Field Blank Trip Blank	USEPA	MONTANA
ANALYTE (units):										MCL*	HHS
DISSOLVED METALS (mg/L)											
Antimony	(Pace 0.00024 J)< 0.0005	SA	SA	SA	(Pace 0.00016 J)< 0.0005	(Pace 0.00013 J)< 0.0005	SA	(Pace 0.00022 J)< 0.0005	< 0.0005	0.006	0.014
Arsenic	0.0013	SA	SA	SA	0.0837	0.0011	SA	0.0858	< 0.0005	0.05	0.01
Barium	0.142	SA	SA	SA	0.0221	0.0165	SA	0.0228	< 0.0003	2	2
Beryllium	< 0.0002	SA	SA	SA	0.00044	< 0.0002	SA	0.00047	< 0.0002	0.004	0.004
Cadmium	< 0.00008	SA	SA	SA	0.0111	0.0013	SA	0.0112	< 0.00008	0.005	0.005
Chromium	(Pace 0.00032 J)< 0.0005	SA	SA	SA	< 0.0005	(Pace 0.00029 J)< 0.0005	SA	(Pace 0.00015)< 0.0005	< 0.0005	0.1	0.1
Cobalt	(Pace 0.00022 J)< 0.0005	SA	SA	SA	0.0344	(Pace 0.00044 J)< 0.0005	SA	0.035	< 0.0005	- - -	- - -
Copper	0.0012	SA	SA	SA	(Pace 0.00085 J)< 0.001	0.0025	SA	(Pace 0.00085 J)< 0.001	0.0157	1.3 (a)	1.3
Iron	(Pace 0.0076 J) < 0.0500	SA	SA	SA	9.77	< 0.05	SA	9.94	< 0.05	0.3(s)	0.3
Lead	< 0.00010	SA	SA	SA	< 0.00010	< 0.00010	SA	< 0.0001	(Pace 0.000045)< 0.0001	0.015 (a)	0.015
Mercury	NR	SA	SA	SA	NR	NR	SA	NR	NR	0.002	0.002
Nickel	(Pace 0.00014 J)< 0.00050	SA	SA	SA	0.0306	0.0502	SA	0.0318	< 0.0005	0.1	0.1
Selenium	0.00071	SA	SA	SA	< 0.0005	< 0.0005	SA	< 0.0005	< 0.0005	0.05	0.05
Silver	NR	SA	SA	SA	NR	NR	SA	NR	NR	0.1	0.1
Thallium	NR	SA	SA	SA	NR	NR	SA	NR	NR	0.002	0.002
Tin	NR	SA	SA	SA	NR	NR	SA	NR	NR		
Vanadium	0.0073	SA	SA	SA	(Pace 0.00047 J)< 0.001	0.0020	SA	(Pace 0.00046 J)< 0.001	< 0.001	- - -	- - -
Zinc	(Pace 0.0048 J)< 0.0050	SA	SA	SA	40.4	0.710	SA	41.2	(Pace 0.0018 J)< 0.005	5	2
INORGANICS (mg/L)											
Chloride	59.8	20.3	41.2	77.3	28.1	59.3	SA	29.9	< 1.0	250	- - -
COD	< 50.0	80.9	(Pace 17.9 J)< 50	388	NR	NR	SA	NR	NR	- - -	- - -
Conductivity (umhos/cm)	853	518	1640	2680	1490	1610	SA	1540	2.9	- - -	- - -
Cyanide	(Pace 0.0054 J)< 0.010	(Pace 0.0047 J)> 0.010	0.0104	0.0163	NR	NR	SA	NR	NR	- - -	0.2
Nitrate\Nitrite - N	1.9	0.16	0.4	0.28	NR	NR	SA	NR	NR	10	10
pH	7.9	7.9	7.4	6.7	7.1	7.2	SA	7.1	5.8		
Sulfate	138	85	711	1500	648	710	SA	655	2.8	250	- - -
Sulfide	SA	SA	SA	SA	NR	NR	SA	NR	NR		
EPA METHOD 8260 (ug/L)											
Acetone	< 20.0	< 20.0	< 20.0	< 20.0	SA	SA	< 20.0	SA	SA	- - -	- - -
Benzene	< 1.0	< 1.0	< 1.0	(Pace 0.47 J)< 1.0	SA	SA	(Pace 0.37 J)< 1.0	SA	SA	5	5
Carbon Disulfide	< 1.0	< 1.0	< 1.0	< 1.0	SA	SA	< 1.0	SA	SA	- - -	- - -
Chloroethane	< 1.0	< 1.0	< 1.0	< 1.0	SA	SA	< 1.0	SA	SA	- - -	- - -
Chloroform	< 1.0	< 1.0	< 1.0	< 1.0	SA	SA	< 1.0	SA	SA	- - -	70
Chlormethane	< 4.0	< 4.0	< 4.0	< 4.0	SA	SA	< 4.0	SA	SA	- - -	- - -
1,4-Dichlorobenzene	< 1.0	< 1.0	< 1.0	1.0	SA	SA	(Pace 0.76 J)< 1.0	SA	SA	75	75
Dichlorodiflouromethane	< 1.0	< 1.0	< 1.0	1.2	SA	SA	(Pace 0.86 J)< 1.0	SA	SA	- - -	1000
1,1-Dichloroethane	< 1.0	< 1.0	< 1.0	1.3	SA	SA	(Pace 0.99 J)< 1.0	SA	SA	- - -	- - -
1,2-Dichloroethane	< 1.0	< 1.0	(Pace 0.55 J)< 1.0	< 1.0	SA	SA	< 1.0	SA	SA	5	4
cis-1,2-Dichloroethene	< 1.0	< 1.0	2.3	3.6	SA	SA	2.7	SA	SA	70	70
trans-1,2-Dichloroethene	< 1.0	< 1.0	< 1.0	< 1.0	SA	SA	< 1.0	SA	SA	100	100
Ethylbenzene	< 1.0	< 1.0	< 1.0	< 1.0	SA	SA	< 1.0	SA	SA		
1,2-Dichloropropane	< 4.0	< 4.0	< 4.0	< 4.0	SA	SA	< 4.0	SA	SA	5	5
4-Isopropyltoluene	NR	NR	NR	NR	SA	SA	NR	SA	SA	- - -	- - -
Methylene Chloride	< 4.0	< 4.0	< 4.0	< 4.0	SA	SA	< 4.0	SA	SA	5	30
Naphthalene	NR	NR	NR	NR	SA	SA	NR	SA	SA	- - -	100
Tetrachloroethene	< 1.0	< 1.0	(Pace 0.85 J)< 1.0	(Pace 0.28 J)< 1.0	SA	SA	< 1.0	SA	SA	5	5
Trichloroethene	< 0.4	< 0.4	0.47	< 0.4	SA	SA	(Pace 0.20 J)< 0.4	SA	SA	5	5
1,2,4-Trimethylbenzene	NR	NR	NR	NR	SA	SA	NR	SA	SA	- - -	- - -
Vinyl Chloride	< 0.2	< 0.2	< 0.2	1.1	SA	SA	0.8	SA	SA	2	0.2
EPA METHOD 8270 (ug/L)											
bis(2-ethylhexyl)Phthalate	SA	SA	SA	SA	SA	SA	SA	SA	SA	6	6
EPA METHOD 8151 (ug/L)											
Picloram	SA	SA	SA	SA	SA	SA	SA	SA	SA		
Dicamba	SA	SA	SA	SA	SA	SA	SA	SA	SA		
2,4,5-TP (Silvex)	SA	SA	SA	SA	SA	SA	SA	SA	SA		
2,4-D	SA	SA	SA	SA	SA	SA	SA	SA	SA		
EPA METHOD 8081 (ug/L)	SA	SA	SA	SA	SA	SA	SA	SA	SA		
EPA METHOD 8082 (ug/L)	SA	SA	SA	SA	SA	SA	SA	SA	SA		

* MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
NA = Not enough sample available for analysis
NR = Analysis Not Requested
ND = Analyte Not Detected
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
NS= Sample Not Collected
SA = Sample Not Taken

Old Butte-Silver Bow County Landfill
GROUNDWATER FIELD CHEMISTRY RESULTS AND PURGE VOLUMES
September-17

Well I.D.	Sample #	Depth (ft)	Radius (ft)	S.W.L. (ft)	TOC Elevation (ft)	Groundwater Elevation (ft)	pH. (su)	E.h. (mV)	S.C. (uS/cm)	T (Celsius)	Sample Time	H2O Volume Req'd (gal)	H2O Volume Purged (gal)	Comments
MBMG-2	BSB-GW-01	23.25	0.17	12.21	5529.88	5517.67	7.33	106.0	820	9.3	10:35	5.50	6.00	
BSB-A1	BSB-GW-02	52.53	0.17	36.00	5531.50	5495.50	7.13	203.7	492	9.3	11:40	10.50	11.00	
BSB-A5	BSB-GW-03	45.60	0.17	41.03	5524.62	5483.59	6.66	278.2	1859	9.4	12:15	2.00	2.00	
BSB-A6-R	BSB-GW-04	59.75	0.17	51.46	5554.41	5502.95	6.29	-262.0	2895	10.5	13:05	4.15	5.00	
BSB-A6-R	BSB-GW-07	59.75	0.17	51.46	5554.41	5502.95	6.29	-262.0	2895	10.5	13:20	4.15	5.00	VOC Duplicate
CLK-1	BSB-GW-05	19.00	0.17	4.83	5478.73	5473.90	6.41	-323.1	1606	9.4	10:45	7.00	7.50	
CLK-2	BSB-GW-06	46.90	0.17	40.88	5511.17	5470.29	6.44	-245.7	1738	9.3	11:35	3.00	4.50	
CLK-1	BSB-GW-08	19.00	0.17	4.83	5478.73	5473.90	6.41	-323.1	1606	9.4	11:00	7.00	7.50	Raw, DM Duplicate
Blank	BSB-GW-09	NA	NA	NA	NA	NA	NA	NA	NA	NA	12:00	NA	NA	Field Blank

KEY:

NA -	Measurement Not Taken
SA -	Sample Not Taken

9/20/17 Old Landfill

Brian Kremer → PTS
Brad Hallman

Weather - cloudy.

Meter calibration:

pH 4.01 - 4.00 SCP-92.5
7.00 - 7.00
10.01 - 10.01

SC 1413 umhos/cm - 1416 umhos/cm

ORP Std 400 mv - @ 18°c read 425 mv.

10:05 Arrive at MBMG-2
DTW - 12.21', TD - 23.25'
Column, 11.04', 2" - dia.
3 Well Vol. - 5.5 gal.

10:15 begin purging w/ 12 volt pump/dedicated tubing

time	temp	pH	ORP	SC	DO
1026	9.1	7.39	107.6	814	5.03
1028	9.1	7.37	107.4	814	4.92
1030	9.2	7.36	107.6	814	4.84
1032	9.2	7.34	107.5	817	4.77
1034	9.3	7.33	1020	820	4.81

1036 collect BSB-GW-01

1-1L, Raw - pH, SC, Cl^-, SO_4^{-2}
1-250ml - Filt/HNO_3 - Dissolved metals
1-250ml - H_2SO_4 - NO_2/NO_3, COD
1-250ml - NaOH - Cyanide
3-40ml VOA - HCl - 8260b

Purged 6 total gallons

11:05 Arrive at BSB-A1
DTW - 36.00', TD - 57'
Column - 21' 2" - dia. casing
3 Well Vol. - 10.5 gallons

11:18 Begin purging w/ 3 stage 12 volt pump
Purging at 2 Liter/min.

9/20/17 BSB-A1 (Cont.)

time	temp	pH	SC	ORP	DO
11:40	9.3	7.13	492	203.7	0.38

11:40 collect BSB-GW-02

1-1L, Raw - pH, SC, Cl^-, SO_4^{-2}
1-250ml - H_2SO_4 - NO_2/NO_3, COD
1-250ml - NaOH - cyanide
3-40ml - VOA - HCl - 8260b

Purged 11 total gallons
water turbid during purging
& at collection.

12:00 Arrive @ BSB-A5
DTW - 41.03' , TD - 45.0'
column - 3.97', 2"-dia. casing
3 well vol. - 2 gal

Bailed 2 gallons using
dedicated bailer

12:15 collect BSB-GW-03

1-1L-Raw - pH, SC, Cl^-, SO_4^{-2}
1-250ml - H_2SO_4 - NO_2-NO_3, COD
1-250ml - NaOH - cyanide
3-40ml VOA - HCl - 8260b.

Water slightly turbid during
bailing.

Temp	pH	SC	ORP	DO
9.4	6.66	1859	278.2	2.87

12:25 Arrive @ BSB-A6R
DTW - 51.46', TD - 59.75'
column - 8.29', 2"-dia casing
3 well vol. 4.15 gallons

12:35 Begin purging w/
3 stage 12 volt pump @
0.75 Liters/min.

Purged 5 total gallons
Water slightly turbid throughout

9/20/17 AGR (cont.)

13:05 collect BSB-GW-04

1-1L-Raw- pH, SC, Cl^-, SO_4^{-2}
1-250ml-H_2SO_4-NO_2/NO_3, COD
1-250ml-NaOH - cyanide
3-40ml VOA-HCl - 8260b

13:20 collect BSB-GW-07

3-40ml VOA-HCl-8260b.

Duplicate of BSB-AGR
Water slightly turbid throughout.
off site.

Temp	pH	SC	ORP	DO
10.5	6.29	2895	-262.0	1.38

BA

9/21/17

B. Kremer PTS
B. Holloman

9:40 Arrive @ CLK-2
DTW - 40.88, TD - 46.90
Column - 6.02', 2" dia. casing
3 Well Vol. - 3 gallons

Pump not working. Go back to office & get different pump

11:20 Begin purging w 3 stage 12 volt pump.

Purge 4.5 total gallons

11:35 collect BSB-GW-06

1-250ml-Filtered/HNO_3 Dissolved metals
1-1L-Raw, pH, SC, Cl^-, SO_4^{-2}

9/21/17

10:05 Arrive at CCK-1
DTW - 4.83', TD - 19.00'
column - 14.17', 2" dia. casing
3 well vol. - 7 gallons

10:15 begin purging w/ 2 stage 12 volt pump.

Purged 7.5 total gallons

10:45 collect BSB-GW-05

1-250ml - Filt./HNO_3, Dissolved metals
1-1L - Raw, pH, SC, Cl^-, SO_4^{-2}

11:00 collect BSB-GW-08
Duplicate of CLK-1

1-250ml-Filt/HNO_3, Dissolved metals
1-1L-Raw, pH, SC, Cl^-, SO_4^{-2}

12:00 collect BSB-GW-09

1-250ml - Filt./HNO_3 Dissolved metals
1-1L Raw, pH, SC, Cl^-, SO_4^{-2}

Field Blank - DI water poured into containers.

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old Landfill

WELL/STATION MBMG-2 DATE 9/20/17 TIME 10:05

SAMPLERS BH, BK WEATHER CONDITIONS Cloudy, Snow/rain, 40's

PHOTO: Yes ____ No X ROLL# ____ NUMBER ____

PURGE DATA:

PURGE METHOD 2 stage 12 volt pump

START PURGING ~~[illegible]~~ 10:15

PURGE RATE 0.5 GPM

RATE CHANGE 1) Time ____ Rate ____

2) Time ____ Rate ____

SAMPLE TIME 1035

WELL DEPTH 23.25 Feet

DEPTH TO WATER 12.21 Feet

COLUMN DEPTH 11.04 Feet

CASING DIAMETER 2 Inch

PUMP SET AT 22 Feet

3 WELL VOLUMES 5.5 Gallons

TOTAL PURGE VOLUME 6 Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-01	250	✓	HNO_3	Dissolved Metals
" " "	1L		Raw	pH, SC, Cl, SO_4^{-2}
" " "	250		H_2SO_4	NO_2/NO_3, COD
" " "	250		NaOH	Cyanide
" " "	40		HCl	8260b

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
1026		9.1	7.39	814	107.6	5.03
1028		9.1	7.36	814	107.4	4.92
1030		9.2	7.36	814	107.6	4.84
1032		9.2	7.34	817	107.5	4.77
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						
1034		9.3	7.33	820	106.0	4.81

FIELD REMARKS:

Pioneer Technical Services

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old Landfill

WELL/STATION BSB-AC

DATE 9/20/17

TIME 11:05 ~~11:18~~ BM

SAMPLERS BM, JEK

WEATHER CONDITIONS cloudy, rain, 40's

PHOTO: Yes ______ No X

ROLL# ______ NUMBER ________

PURGE DATA:

PURGE METHOD 3 Stage 12 volt

START PURGING 11:18

PURGE RATE 0.5 GPM

RATE CHANGE 1) Time ______ Rate ________

2) Time ______ Rate ________

SAMPLE TIME ~~0.5 gpm~~ BM 1140

WELL DEPTH 57 Feet

DEPTH TO WATER 36 Feet

COLUMN DEPTH 21 Feet

CASING DIAMETER 2 Inch

PUMP SET AT 55 Feet

3 WELL VOLUMES 10.5 Gallons

TOTAL PURGE VOLUME 11 Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-08	1L		Raw	pH, SC, Cl, SO4^2
" "	250		H2SO4	NO2/NO3, COD
" "	250		NaOH	Cyanide
" "	40		HCl	8260.b

FIELD PARAMATERS:

TIME	Amount Purged (gallons)	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
1128	5	9.2	7.18	492	168.0	0.30
1130	6	9.2	7.17	493	132.6	0.29
1132	7	9.2	7.15	497	188.4	0.28
1134	8	9.2	7.14	497	184.7	0.33
1136	9	9.3	7.13	493	138.1	0.35
1138	10	9.3	7.13	492	198.2	0.36
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						
1140	11	9.3	7.13	491	203.7	0.38

FIELD REMARKS: ORP all over - not sure if probe is good. Water very turbid @ collection.

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old Landfill

WELL/STATION BSSB-AGR DATE 9/20/17 TIME 12:25

SAMPLERS BSK,BC WEATHER CONDITIONS Cloudy, 40's.

PHOTO: Yes ______ No X ROLL# ______ NUMBER ______

PURGE DATA:

PURGE METHOD 12volt-3stage

START PURGING 12:55

PURGE RATE 0.75 ~~GPM~~ LPm

RATE CHANGE 1) Time ______ Rate ______

2) Time ______ Rate ______

SAMPLE TIME ______

WELL DEPTH 59.75 Feet

DEPTH TO WATER 51.46 Feet

COLUMN DEPTH 8.29 Feet

CASING DIAMETER 2 Inch

PUMP SET AT 58 Feet

3 WELL VOLUMES 4.15 Gallons

TOTAL PURGE VOLUME 5 Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSSB-GW-04	1L		Raw	pH, SC, Cl^-, SO_4^{-2}
" " "	250		H_2SO_4	NO_2/NO_3, COD
" " "	250		NaOH	Cyanide
" " "	40		HCl	8260b

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
1255		10.4	6.30	2902	~~+51~~ -254.7	1.51
1257		10.4	6.30	2901	-258.7	1.45
1259		10.4	6.29	2901	-258.2	1.42
1301		10.5	6.29	2895	-261.0	1.39
~~1303~~						
~~1305~~						
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						
1303		10.5	6.29	2895	-262.0	1.38

FIELD REMARKS: ______

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old Landfill/Clark Tailings

WELL/STATION CLK-1 DATE 9/21/17 TIME 10:05

SAMPLERS BSH, BSK WEATHER CONDITIONS Cloudy, 40's

PHOTO: Yes ______ No X ROLL# ______ NUMBER ______

PURGE DATA:

PURGE METHOD 2 Stage 12 volt

START PURGING 10:15

PURGE RATE ~~Liter/GPM~~ .25 GPM

RATE CHANGE 1) Time ______ Rate ______

2) Time ______ Rate ______

SAMPLE TIME 1045

WELL DEPTH 19.00 Feet

DEPTH TO WATER 4.83 Feet

COLUMN DEPTH 14.17 Feet

CASING DIAMETER 2 Inch

PUMP SET AT 15 Feet

3 WELL VOLUMES 7 Gallons

TOTAL PURGE VOLUME 7.5 Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
15 BSB-GW-05		✓	HNO3	Dissolved metals
" " "			Raw	pH, SC, Cl⁻, SO4⁻2
00 BSB-GW-08		✓	HNO3	Dissolved Metals
" " "			Raw	pH, SC, Cl⁻, SO4⁻2

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
1030		9.4	6.43	1595	-309.6	.51
1033		9.4	6.42	1598	-314.2	.41
1036		9.4	6.42	1600	-317.3	.37
1039		9.4	6.42	1605	-321.0	.30
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						
1042		9.4	6.41	1606	-323.1	.27

FIELD REMARKS: Duplicate @ CLK-1 BSB-GW-08

Pioneer Technical Services

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old Landfill/Clark Tailings

WELL/STATION CLC-I DATE 9/21/17 TIME 9:40

SAMPLERS JSA, JSK WEATHER CONDITIONS Cloudy, 40's

PHOTO: Yes ______ No X ROLL# ______ NUMBER ______

PURGE DATA:

PURGE METHOD 3 Stage 12volt

START PURGING 11:20

PURGE RATE ______ GPM

RATE CHANGE 1) Time ______ Rate ______

2) Time ______ Rate ______

SAMPLE TIME 1135

WELL DEPTH 46.90 Feet

DEPTH TO WATER 40.88 Feet

COLUMN DEPTH 6.02 Feet

CASING DIAMETER 2 Inch

PUMP SET AT 45 Feet

3 WELL VOLUMES 3 Gallons

TOTAL PURGE VOLUME 4.5 Gallons

SAMPLE DATA:

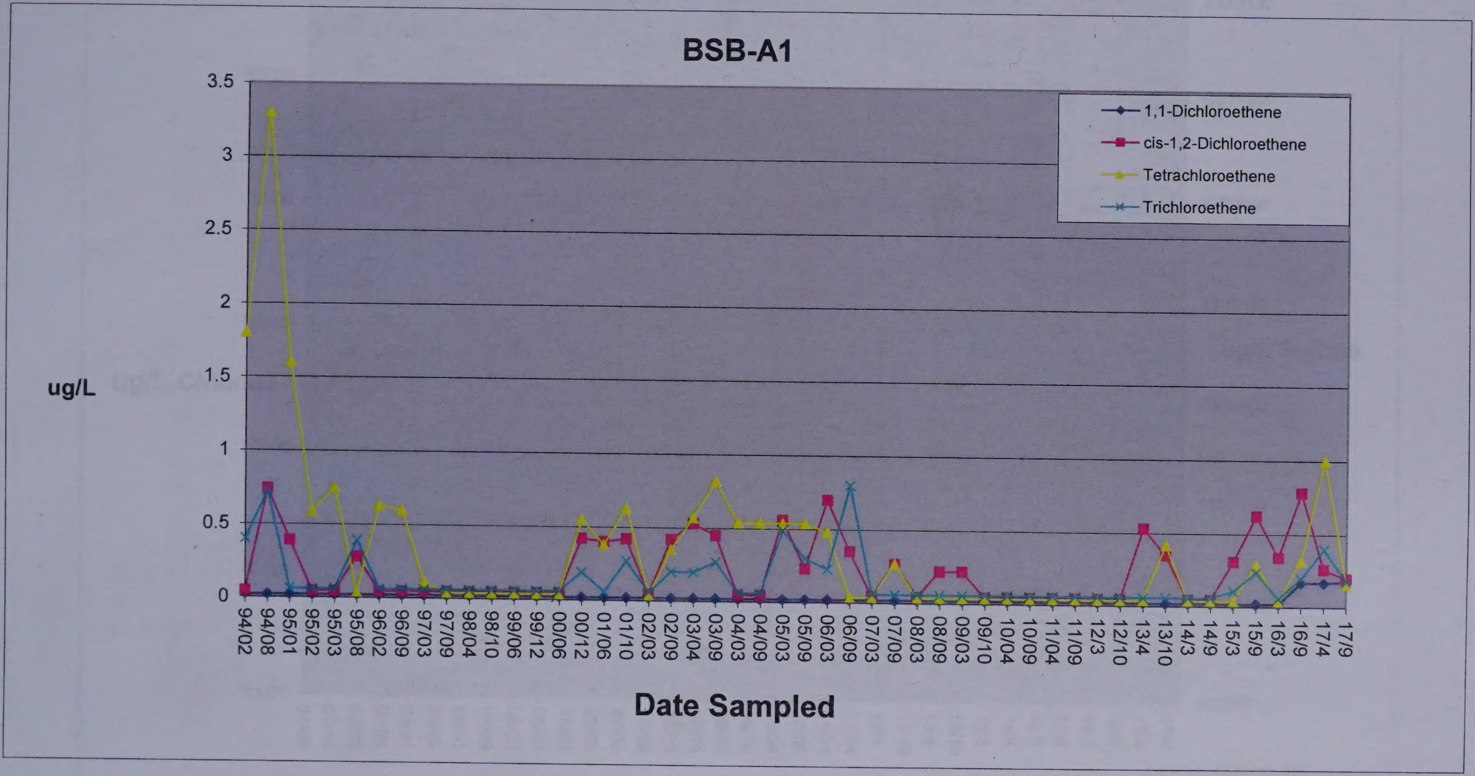
SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-06		✓	HNO3	Dissolved metals
" " "			Raw	pH, SC, Cl, SO4-2

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
1122		9.5	6.52	1710	-292.5	2.65
1124		9.4	6.48	1721	-237.2	2.00
1126		9.3	6.47	1736	-245.3	1.40
1128		9.3	6.46	1737	-245.6	1.46
1130		9.3	6.45	1738	-245.2	1.44
		9				
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						
1132		9.3	6.44	1738	-245.7	1.48

FIELD REMARKS: ______

Pioneer Technical Services


BSB-A1
3.5
3
2.5
2
1.5
1
0.5
0
ug/L
1,1-Dichloroethene
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
94/02
94/08
95/01
95/02
95/03
95/08
96/02
96/09
97/03
97/09
98/04
98/10
99/06
99/12
00/06
00/12
01/06
01/10
02/03
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03/04
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11/04
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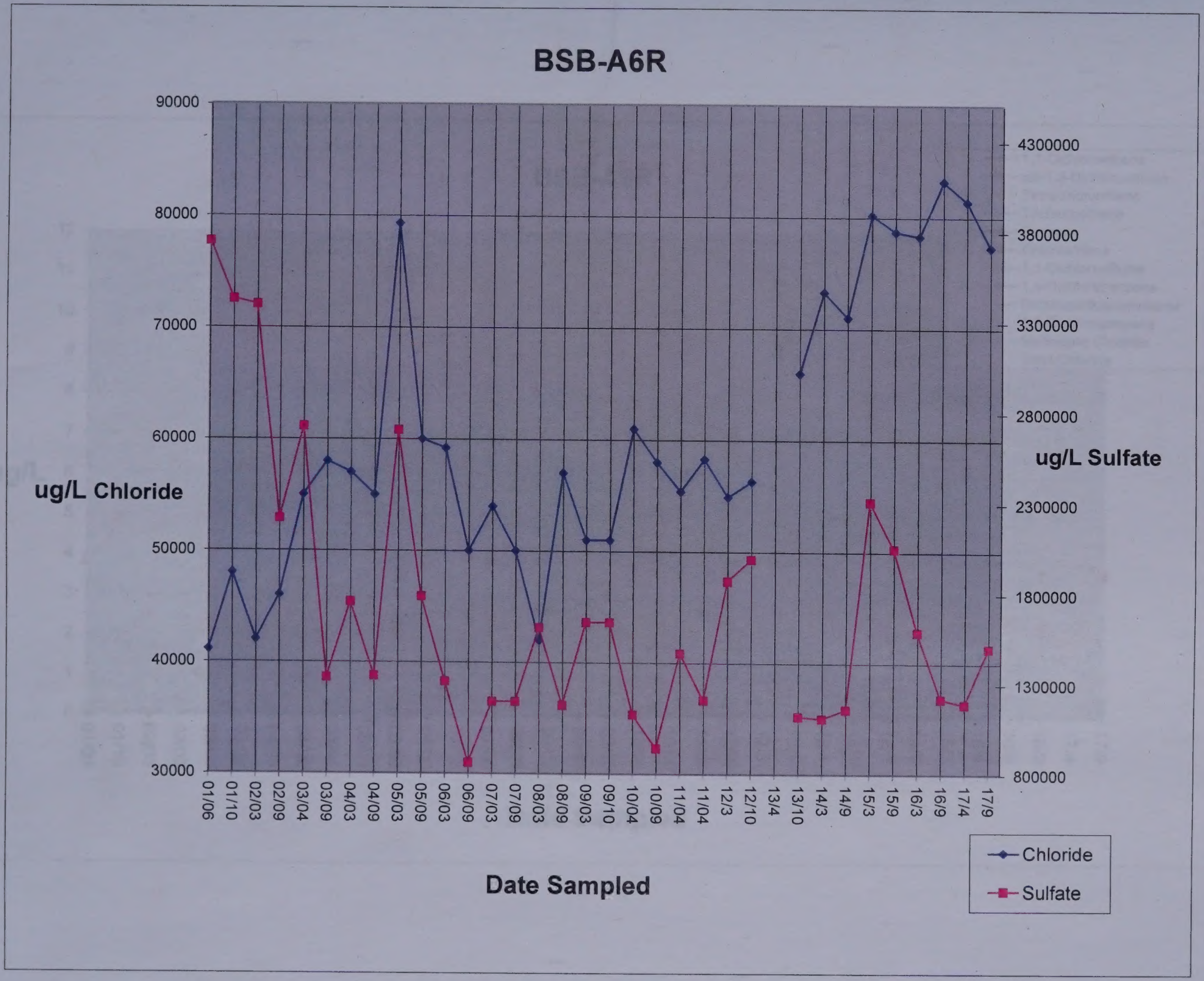
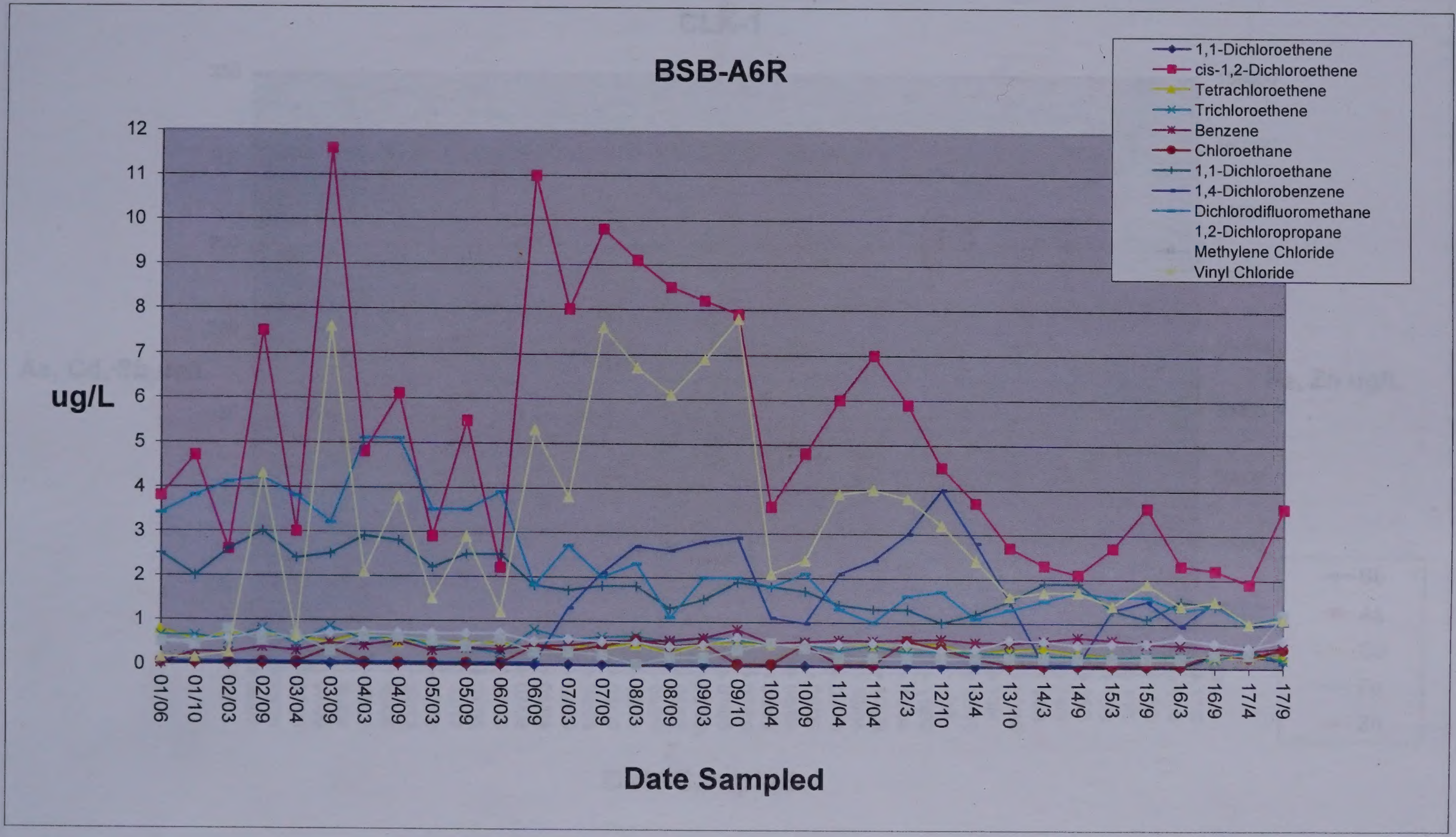
15/9
16/3
16/9
17/4
17/9
Date Sampled


BSB-A6R
ug/L Chloride
90000
80000
70000
60000
50000
40000
30000
ug/L Sulfate
4300000
3800000
3300000
2800000
2300000
1800000
1300000
800000
Date Sampled
01/06
01/10
02/03
02/09
03/04
03/09
04/03
04/09
05/03
05/09
06/03
06/09
07/03
07/09
08/03
08/09
09/03
09/10
10/04
10/09
11/04
11/04
12/3
12/10
13/4
13/10
14/3
14/9
15/3
15/9
16/3
16/9
17/4
17/9
Chloride
Sulfate


BSB-A6R
ug/L
12
11
10
9
8
7
6
5
4
3
2
1
0
01/06
01/10
02/03
02/09
03/04
03/09
04/03
04/09
05/03
05/09
06/03
06/09
07/03
07/09
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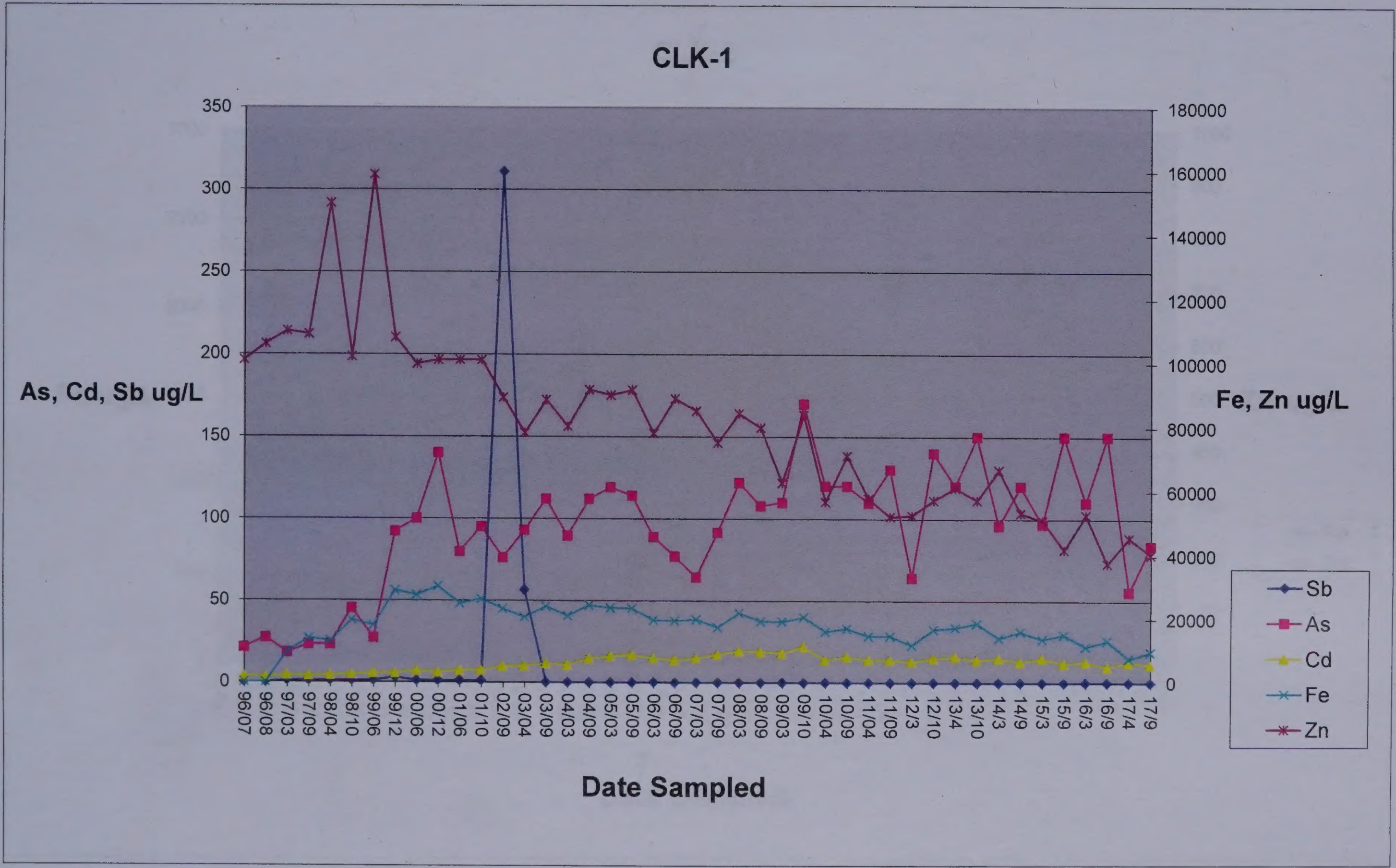
09/10
10/04
10/09
11/04
11/04
12/3
12/10
13/4
13/10
14/3
14/9
15/3
15/9
16/3
16/9
17/4
17/9
Date Sampled
1,1-Dichloroethene
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Benzene
Chloroethane
1,1-Dichloroethane
1,4-Dichlorobenzene
Dichlorodifluoromethane
1,2-Dichloropropane
Methylene Chloride
Vinyl Chloride


CLK-1
As, Cd, Sb ug/L
350
300
250
200
150
100
50
0
Fe, Zn ug/L
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
96/07
96/08
97/03
97/09
98/04
98/10
99/06
99/12
00/06
00/12
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03/04
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10/04
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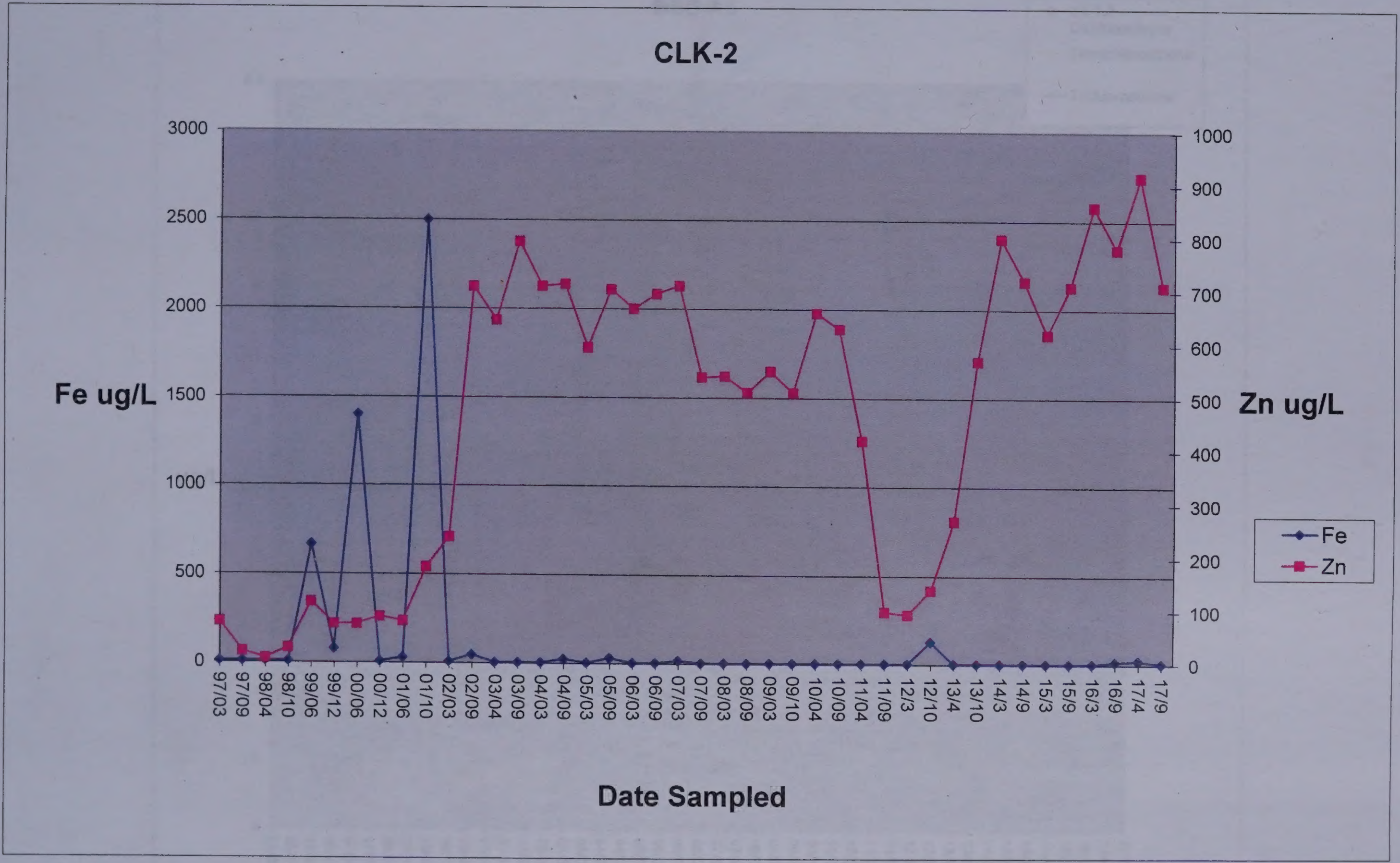
11/04
11/09
12/3
12/10
13/4
13/10
14/3
14/9
15/3
15/9
16/3
16/9
17/4
17/9
Date Sampled
Sb
As
Cd
Fe
Zn


CLK-2
Fe ug/L
3000
2500
2000
1500
1000
500
0
Zn ug/L
1000
900
800
700
600
500
400
300
200
100
0
97/03
97/09
98/04
98/10
99/06
99/12
00/06
00/12
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12/3
12/10
13/4
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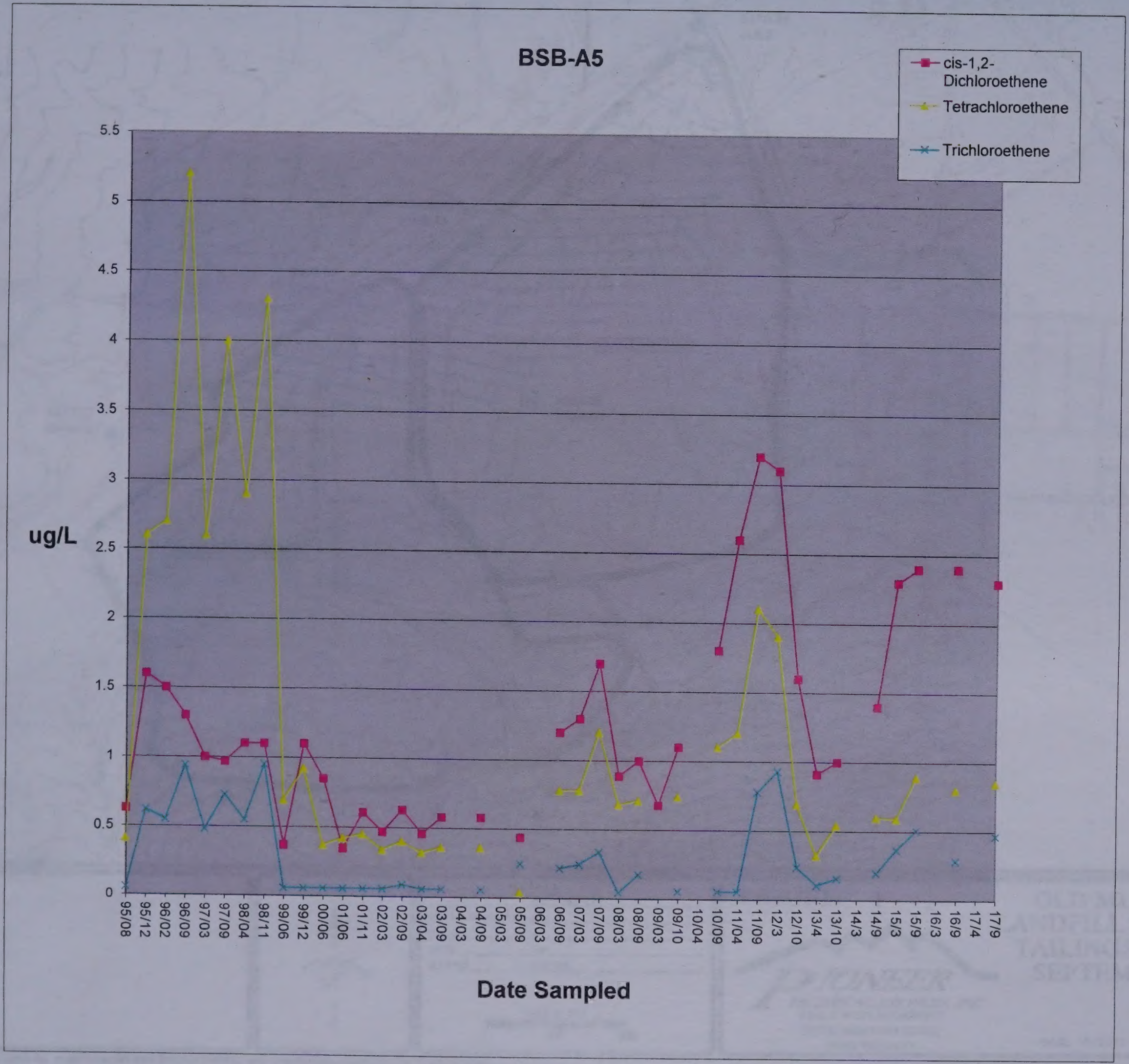
16/3
16/9
17/4
17/9
Date Sampled
Fe
Zn


BSB-A5
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
ug/L
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
95/08
95/12
96/02
96/09
97/03
97/09
98/04
98/11
99/06
99/12
00/06
01/06
01/11
02/03
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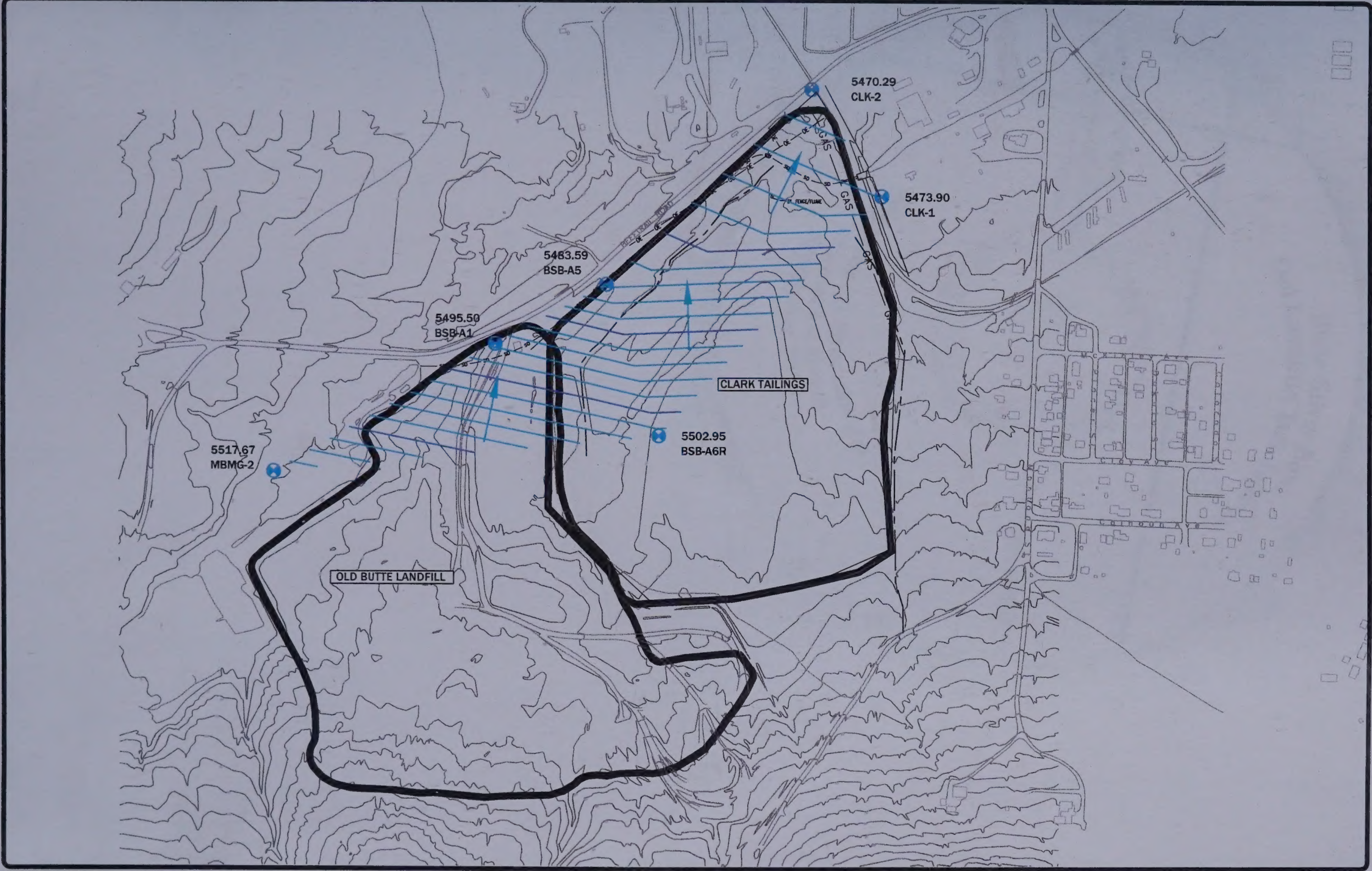
17/4
17/9
Date Sampled


5470.29
CLK-2
5473.90
CLK-1
5483.59
BSB-A5
5495.50
BSB-A1
CLARK TAILINGS
5502.95
BSB-A6R
5517.67
MBMG-2
OLD BUTTE LANDFILL
GAS

LEGEND

CLK-1 ● MONITORING WELL

—— CONTOUR

CONTOUR INTERVAL= 10'

N

DISPLAYED AS:	
COORD SYS/ZONE:	NA
DATUM:	NA
UNITS:	FEET
SOURCE:	PIONEER

SCALE IN FEET
0 300 600

FIGURE 1

PIONEER
TECHNICAL SERVICES, INC.
63-1/2 WEST BROADWAY
BUTTE, MONTANA 59701
(406) 782-5177

OLD MUNICIPAL
LANDFILL SITE/CLARK
TAILINGS FACILITY
SEPTEMBER 2017

DATE: 10/2017

10/23/2017 1:12:54 PM P:\BUTTE-SILVER BOW\BSB OLD LANDFILL\OLD LANDFILL\2017\OLDLNDFL-FG-PLN-002-17.DWG

Butte-Silver Bow
Old Landfill/Clark Tailings

PIONEER
TECHNICAL SERVICES, INC.

November 2017

Semi-Annual Groundwater
Monitoring Event
September 2017

PIONEER
TECHNICAL SERVICES, INC.

June 2, 2017

#20

RECEIVED
JUN 05 2017
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

Mr. John Collins
Montana DEQ/Solid Waste Program
P.O. Box 200901
Helena, Montana 59620-0901

RE: Old Butte-Silver Bow County Landfill/Clark Tailings

Dear John:

Enclosed are results from the Old Butte-Silver Bow County Landfill/Clark Tailings April 2017 semi-annual groundwater monitoring event. The following have been included for your information:

- April 2017 Groundwater Monitoring Summary;
- Table 1: Analytical Data Summary;
- Table oldlfctAprilSTX17 (non-parametric comparison of wells) (is provided electronically on the CD);
- Groundwater field parameters collected in the field;
- Copy of field notes;
- Trend graphs of detected compounds;
- Figure 1: Groundwater Potentiometric Surface Map for April 2017; and
- Laboratory data sheets from Pace Laboratories located in Minneapolis, Minnesota.

Pioneer has calculated a confidence level of 97.9 % per the formula [n/(n+k)] established by the *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities Addendum to Interim Final Guidance* (EPA, 1992).

The groundwater and seepage velocities were calculated using Darcy's Law. The average groundwater velocity for the April 2017 sampling event was 0.229 feet per day (ft/day). The hydraulic conductivity value (2.83 ft/day) used to calculate the groundwater velocity was obtained from the *Corrective Measures Assessment Report* (Pioneer, 2009) and from the March 2009 pumping data.

Sincerely,

Joseph S McElroy

Joe McElroy, P.E.
Project Manager

Encl.

HEADQUARTERS: PO BOX 3445 • BUTTE, MT 59702 | PH: 406.782.5177 • FX: 406.782.5866 | WWW.PIONEER-TECHNICAL.COM
ANACONDA • BILLINGS • BOZEMAN • HELENA • MISSOULA • EVANSTON, WY • KELLOGG, ID

cc. Dave Schultz, BSB Landfill Manager
Eric Hassler, BSB Health Department, 25 W. Front Street, Butte, MT 59701
Brandon Warner, BSB Health Department, 25 W. Front Street, Butte, MT 59701
Loren Burmeister, Atlantic Richfield (email)
Cord Harris, Atlantic Richfield (email)
Irene Montero, Atlantic Richfield (email)
70.04.25.16 – MiningSharePoint@bp.com

OLD SILVER BOW LANDFILL
APRIL 2017 GROUNDWATER MONITORING

The April 2017 sampling event at the Old Butte-Silver Bow Landfill included sampling in accordance with the modified assessment-monitoring program. The attached Table 1 summarizes the analytical results. The discussion below compares the April 2017 results to previous results, current Maximum Contaminant Levels (MCLs), and the Montana Human Health Standards (HHSs).

Well MBMG-2 (Upgradient):

In accordance with the modified assessment-monitoring program, semi-volatiles, chlorinated acids, and pesticides were not collected in this well during the April 2017 sampling event. No volatile compounds were detected during this sampling event. Metals that were detected below the maximum background concentrations are; arsenic (As) (.0013 mg/L), barium (Ba) (0.134 mg/L), cadmium (Cd) (0.000013 J mg/L), chromium (Cr) (0.00083 J mg/L), cobalt (Co) (0.00024 J mg/L), copper (Cu) (0.0011 mg/L), nickel (Ni) (0.00022 J mg/L), Selenium (Se) (0.0001 mg/l) and vanadium (V) (0.0071 mg/l). There were no metals detected above the maximum background concentrations during this sampling event. Nitrate/nitrite (3.80 mg/L), Chloride (57 mg/l), and Sulfate (129 mg/L) were detected at concentrations below the maximum background. No MCL or HHS exceedances were observed in well MBMG-2 during the April 2017 sampling event.

Well BSB-A1 (North):

In accordance with the modified assessment-monitoring program, semi-volatile, chlorinated acids, pesticides and a sample for metals analyses were not collected from well BSB-A1during the April 2017 sampling event.

There were no volatile compounds detected at levels above the maximum baseline or background in this well during this sampling event.

No MCL or HHS exceedences were observed in this well during the April 2017 sampling event.

Well BSB-A5 (Northeast Well):

In accordance with the modified assessment-monitoring program, semi-volatile, chlorinated acids, pesticides and a sample for metals analyses were not collected from well BSB –A5 during the April 2017 sampling event. The well was dry and sampling was unable to be completed.

Well BSB-A6-R (Central Well):

Well BSB-A6-R is the replacement well for BSB-A6, removed during the construction of Timber Butte Youth Park. Eight volatile organic compounds (VOC's) were detected in

well BSB-A6-R. Two of the eight were detected at levels below the quantification limit. The eight volatile organic compounds detected in BSB-A6-R during the April 2017 sampling event were as follows:

- Acetone (5.4 J ug/L);
- Benzene (0.39 J ug/L);
- 1,4-Dichlorobenzene (0.96 ug/L);
- Dichlorodifluoromethane (0.99 ug/L);
- 1,1-Dichloroethane (1.1 ug/L);
- Cis-1,2-DCE (1.9 ug/L); exceeds maximum background.
- 1,2-Dichloropropane (0.46 J ug/L);
- Vinyl Chloride (1.0 ug/L); exceeds maximum background.

Vinyl Chloride exceeds the MDEQ-7 HHS standard of 0.2 ug/L.

In accordance with the modified assessment-monitoring program, semi-volatile, chlorinated acids, pesticides and a sample for metals analyses were not collected from this well.

Sulfate (1,190 mg/L), Specific Conductance (2,470 umhom/cm), Cyanide (33.2 ug/L) and COD (386 mg/L) exceeded maximum background concentrations. Sulfate exceeds the secondary EPA MCL of 250 mg/L.

Chloride (81.4 mg/L) exceeds maximum background concentration of 70 mg/L and the maximum baseline of 80 mg/L.

Well CLK-1 (Clark Tailings East Well):

In accordance with the modified assessment-monitoring program, no samples for organic analyses were collected from well CLK-1. Metals detected above maximum background but below maximum baseline are; As (0.0556 mg/L); Cd (0.0126 mg/L); Co (0.0299 mg/L), iron (Fe) (7.73 mg/L), Ni (0.0331 mg/L) and zinc (Zn)(45.6 mg/L). Arsenic, cadmium, iron and zinc exceed EPA MCL or Montana HHS standards.

Sulfate was detected at a concentration of 669 mg/L, which exceeds the maximum background and the secondary MCL for this compound. Specific Conductance detected at 1,480 umhos/cm exceeds maximum background concentration.

Well CLK-2 (Clark Tailings North Well):

In accordance with the modified assessment-monitoring program, no samples for organic analyses were collected from well CLK-2 during the April 2017 sampling event. Cadmium (0.0014 mg/L), Ni (0.054 mg/L) and Zn (0.91 mg/L) were all detected above maximum background.

Sulfate was detected at a concentration of 710 mg/L, which exceeds the maximum background and the secondary MCL for this compound. Specific Conductance detected at 1,680 umhos/cm exceeds maximum background concentration.

Conclusion:

The September 2016 sampling event at the Old Butte-Silver Bow Landfill included sampling according to the modified assessment-monitoring program (see Table 1 for analytical data). The results for metals, inorganics, and organic contaminants obtained from April 2017 sampling event were comparable to previous results.

TABLES

SAMPLE NUMBER WELL ANALYTE (units):	BSB-GW-O1 MBMG-2		GW-08 DUPE	BSB-GW-09 Field Blank Trip Blank	GW PROTECTION STANDARDS USEPA MCL*	 MONTANA HHS
DISSOLVED METALS (mg/L)						
Antimony	(Pace 0.00025 J)< 0.0005		)< 0.0005	< 0.0005	0.006	0.014
Arsenic	0.0013		0.0564	< 0.0005	0.05	0.01
Barium	0.134		0.020	(Pace 0.000037 J)< 0.0003	2	2
Beryllium	< 0.00020		0.00039	< 0.0002	0.004	0.004
Cadmium	(Pace 0.000013 J)< 0.00008		0.0122	< 0.00008	0.005	0.005
Chromium	0.0008		< 0.00050	(Pace 0.00026 J)< 0.0005	0.1	0.1
Cobalt	(Pace 0.00024 J)< 0.0005		0.02960	< 0.0005	- - -	- - -
Copper	0.0011		)< 0.0010	< 0.001	1.3 (a)	1.3
Iron	< 0.05		7.630	< 0.050	0.3(s)	0.3
Lead	(Pace 0.000016 J)< 0.00010		)< 0.00010	< 0.0001	0.015 (a)	0.015
Mercury	SA		SA	NR	0.002	0.002
Nickel	(Pace 0.00022 J)< 0.0005		0.0324	< 0.0005	0.1	0.1
Selenium	0.00010		< 0.0005	< 0.0005	0.05	0.05
Silver	NR		NR	NR	0.1	0.1
Thallium	NR		NR	NR	0.002	0.002
Tin	NR		NR	NR		
Vanadium	0.0071		)< 0.0010	< 0.001	- - -	- - -
Zinc	(Pace 0.0031 J)< 0.0050		44.000	< 0.005	5	2
INORGANICS (mg/L)						
Chloride	57		30.4	< 1.0	250	- - -
COD	< 50.0	(Pa	NR	SA	- - -	- - -
Conductivity (umhos/cm)	765		1480	2.8	- - -	- - -
Cyanide	< 0.010		NR	NR	- - -	0.2
Nitrate\Nitrite - N	3.8		NR	NR	10	10
pH	7.1		6.1	5.1		
Sulfate	129		692	< 2.5	250	- - -
Sulfide	SA		NR	NR		
EPA METHOD 8260 (ug/L)						
Acetone	(Pace 7.7 J)< 20.0	(Pa	SA	SA	- - -	- - -
Benzene	(Pace 0.36 J)< 1.0	(Pac	SA	SA	5	5
Carbon Disulfide	< 1.0		SA	SA	- - -	- - -
Chloroethane	< 1.0		SA	SA	- - -	- - -
Chloroform	< 1.0		SA	SA	- - -	70
Chlormethane	< 4.0		SA	SA	- - -	- - -
1,4-Dichlorobenzene	< 1.0		SA	SA	75	75
Dichlorodiflouromethane	< 1.0		SA	SA	- - -	1000
1,1-Dichloroethane	< 1.0		SA	SA	- - -	- - -
1,2-Dichloroethane	< 1.0		SA	SA	5	4
cis-1,2-Dichloroethene	< 1.0	(Pac	SA	SA	70	70
trans-1,2-Dichloroethene	< 1.0		SA	SA	100	100
Ethylbenzene	< 1.0		SA	SA		
1,2-Dichloropropane	< 4.0		SA	SA	5	5
4-Isopropyltoluene	NR		SA	SA	- - -	- - -
Methylene Chloride	< 4.0		SA	SA	5	30
Naphthalene	NR		SA	SA	- - -	100
Tetrachloroethene	< 1.0		SA	SA	5	5
Trichloroethene	< 0.4		SA	SA	5	5
1,2,4-Trimethylbenzene	NR		SA	SA	- - -	- - -
Vinyl Chloride	< 0.4		SA	SA	2	0.2
EPA METHOD 8270 (ug/L)						
bis(2-ethylhexyl)Phthalate	SA		SA	SA	6	6
EPA METHOD 8151 (ug/L)						
Picloram	SA		SA	SA		
Dicamba	SA		SA	SA		
2,4,5-TP (Silvex)	SA		SA	SA		
2,4-D	SA		SA	SA		
EPA METHOD 8081 (ug/L)						
	SA		SA	SA		
EPA METHOD 8082 (ug/L)						
	SA		SA	SA		

* MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
NA = Not enough sample available for analysis
NR = Analysis Not Requested
ND = Analyte Not Detected
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
NS= Sample Not Collected (Dry Well-BSB-A5)
SA = Sample Not Taken

TABLE I: ANALYTICAL DATA FOR GROUNDWATER SAMPLES, OLD SILVER BOW COUNTY LANDFILL
DATE SAMPLED: April 5 & 6, 2017

SAMPLE NUMBER WELL ANALYTE (units):	BSB-GW-O1 MBMG-2	BSB-GW-O2 BSB-A1	BSB-GW-O3 BSB-A5	BSB-GW-O4 BSB-A6-R	BSB-GW-O5 CLK-1	BSB-GW-O6 CLK-2	BSB-GW-07 BSB-A6R DUPE	BSB-GW-08 CLK-1 DUPE	BSB-GW-09 Field Blank Trip Blank	GW PROTECTION STANDARDS	
										USEPA MCL*	MONTANA HHS
DISSOLVED METALS (mg/L)											
Antimony	(Pace 0.00025 J)< 0.0005	SA	SA	SA	(Pace 0.00017 J)< 0.0005	(Pace 0.00017 J)< 0.0005	SA	(Pace 0.00027 J)< 0.0005	< 0.0005	0.006	0.014
Arsenic	0.0013	SA	SA	SA	0.056	0.0013	SA	0.0564	< 0.0005	0.05	0.01
Barium	0.134	SA	SA	SA	0.021	0.017	SA	0.020	(Pace 0.000037 J)< 0.0003	2	2
Beryllium	< 0.00020	SA	SA	SA	0.00039	< 0.0002	SA	0.00039	< 0.0002	0.004	0.004
Cadmium	(Pace 0.000013 J)< 0.00008	SA	SA	SA	0.0126	0.0014	SA	0.0122	< 0.00008	0.005	0.005
Chromium	0.0008	SA	SA	SA	(Pace 0.00016 J)< 0.0005	(Pace 0.00022 J)< 0.0005	SA	< 0.00050	(Pace 0.00026 J)< 0.0005	0.1	0.1
Cobalt	(Pace 0.00024 J)< 0.0005	SA	SA	SA	0.0299	0.0005	SA	0.02960	< 0.0005	- - -	- - -
Copper	0.0011	SA	SA	SA	(Pace 0.00090 J)< 0.0010	0.0023	SA	(Pace 0.001 J)< 0.0010	< 0.001	1.3 (a)	1.3
Iron	< 0.05	SA	SA	SA	7.73	(Pace 0.0251 J)< 0.050	SA	7.630	< 0.050	0.3(s)	0.3
Lead	(Pace 0.000016 J)< 0.00010	SA	SA	SA	(Pace 0.00016 J)< 0.00010	Pace 0.000017 J)< 0.00010	SA	(Pace 0.000030 J)< 0.00010	< 0.0001	0.015 (a)	0.015
Mercury	SA	SA	SA	SA	SA	SA	SA	SA	NR	0.002	0.002
Nickel	(Pace 0.00022 J)< 0.0005	SA	SA	SA	0.0310	0.0540	SA	0.0324	< 0.0005	0.1	0.1
Selenium	0.00010	SA	SA	SA	< 0.0005	< 0.0005	SA	< 0.0005	< 0.0005	0.05	0.05
Silver	NR	SA	SA	SA	NR	NR	SA	NR	NR	0.1	0.1
Thallium	NR	SA	SA	SA	NR	NR	SA	NR	NR	0.002	0.002
Tin	NR	SA	SA	SA	NR	NR	SA	NR	NR		
Vanadium	0.0071	SA	SA	SA	(Pace 0.00035 J)< 0.001	0.0021	SA	(Pace 0.00030 J)< 0.0010	< 0.001	- - -	- - -
Zinc	(Pace 0.0031 J)< 0.0050	SA	SA	SA	45.6	0.916	SA	44.000	< 0.005	5	2
INORGANICS (mg/L)											
Chloride	57	19.6	NS	81.4	29.6	66.6	SA	30.4	< 1.0	250	- - -
COD	< 50.0	(Pace 19.0 J)< 50.0	NS	386	NR	NR	SA	NR	SA	- - -	- - -
Conductivity (umhos/cm)	765	482	NS	2470	1480	1680	SA	1480	2.8	- - -	- - -
Cyanide	< 0.010	> 0.010	NS	Pace 0.0332 J)< 0.010	NR	NR	SA	NR	NR	- - -	0.2
Nitrate\Nitrite - N	3.8	0.27	NS	0.29	NR	NR	SA	NR	NR	10	10
pH	7.1	7.0	NS	5.7	5.9	6.2	SA	6.1	5.1		
Sulfate	129	74	NS	1190	669	710	SA	692	< 2.5	250	- - -
Sulfide	SA	SA	NS	SA	NR	NR	SA	NR	NR		
EPA METHOD 8260 (ug/L)											
Acetone	(Pace 7.7 J)< 20.0	(Pace 4.4 J)< 20.0	NS	(Pace 5.4 J)< 20.0	SA	SA	(Pace 4.2 J)< 20.0	SA	SA	- - -	- - -
Benzene	(Pace 0.36 J)< 1.0	(Pace 0.18 J)< 1.0	NS	(Pace 0.39 J)< 1.0	SA	SA	(Pace 0.45 J)< 1.0	SA	SA	5	5
Carbon Disulfide	< 1.0	< 1.0	NS	< 1.0	SA	SA	< 1.0	SA	SA	- - -	- - -
Chloroethane	< 1.0	< 1.0	NS	< 1.0	SA	SA	< 1.0	SA	SA	- - -	- - -
Chloroform	< 1.0	< 1.0	NS	< 1.0	SA	SA	< 1.0	SA	SA	- - -	70
Chlormethane	< 4.0	< 4.0	NS	< 4.0	SA	SA	< 4.0	SA	SA	- - -	- - -
1,4-Dichlorobenzene	< 1.0	< 1.0	NS	(Pace 0.96 J)< 1.0	SA	SA	1.0	SA	SA	75	75
Dichlorodiflouromethane	< 1.0	< 1.0	NS	(Pace 0.99 J)< 1.0	SA	SA	1.1	SA	SA	- - -	1000
1,1-Dichloroethane	< 1.0	< 1.0	NS	1.1	SA	SA	1.1	SA	SA	- - -	- - -
1,2-Dichloroethane	< 1.0	< 1.0	NS	< 1.0	SA	SA	< 1.0	SA	SA	5	4
cis-1,2-Dichloroethene	< 1.0	(Pace 0.26 J)< 1.0	NS	1.9	SA	SA	1.9	SA	SA	70	70
trans-1,2-Dichloroethene	< 1.0	< 1.0	NS	< 1.0	SA	SA	< 1.0	SA	SA	100	100
Ethylbenzene	< 1.0	< 1.0	NS	< 1.0	SA	SA	(Pace 0.33 J)< 1.0	SA	SA		
1,2-Dichloropropane	< 4.0	< 4.0	NS	(Pace 0.46 J)< 4.0	SA	SA	(Pace 0.61 J)< 4.0	SA	SA	5	5
4-Isopropyltoluene	NR	NR	NS	NR	SA	SA	NR	SA	SA	- - -	- - -
Methylene Chloride	< 4.0	< 4.0	NS	< 4.0	SA	SA	< 4.0	SA	SA	5	30
Naphthalene	NR	NR	NS	NR	SA	SA	NR	SA	SA	- - -	100
Tetrachloroethene	< 1.0	< 1.0	NS	< 1.0	SA	SA	< 1.0	SA	SA	5	5
Trichloroethene	< 0.4	< 0.4	NS	< 0.4	SA	SA	< 0.4	SA	SA	5	5
1,2,4-Trimethylbenzene	NR	NR	NS	NR	SA	SA	NR	SA	SA	- - -	- - -
Vinyl Chloride	< 0.4	< 0.4	NS	1.0	SA	SA	1.5	SA	SA	2	0.2
EPA METHOD 8270 (ug/L)											
bis(2-ethylhexyl)Phthalate	SA	SA	SA	SA	SA	SA	SA	SA	SA	6	6
EPA METHOD 8151 (ug/L)											
Picloram	SA	SA	SA	SA	SA	SA	SA	SA	SA		
Dicamba	SA	SA	SA	SA	SA	SA	SA	SA	SA		
2,4,5-TP (Silvex)	SA	SA	SA	SA	SA	SA	SA	SA	SA		
2,4-D	SA	SA	SA	SA	SA	SA	SA	SA	SA		
EPA METHOD 8081 (ug/L)	SA	SA	SA	SA	SA	SA	SA	SA	SA		
EPA METHOD 8082 (ug/L)	SA	SA	SA	SA	SA	SA	SA	SA	SA		

* MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
NA = Not enough sample available for analysis
NR = Analysis Not Requested
ND = Analyte Not Detected
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
NS= Sample Not Collected (Dry Well-BSB-A5)
SA = Sample Not Taken

Old Butte-Silver Bow County Landfill
GROUNDWATER FIELD CHEMISTRY RESULTS AND PURGE VOLUMES
April-17

Well I.D.	Sample #	Depth (ft)	Radius (ft)	S.W.L. (ft)	TOC Elevation (ft)	Groundwater Elevation (ft)	pH. (su)	E.h. (mV)	S.C. (uS/cm)	T (Celsius)	Sample Time	H2O Volume Req'd (gal)	H2O Volume Purged (gal)	Comments
MBMG-2	BSB-GW-01	23.2	0.17	11.37	5529.88	5518.51	7.32	120.7	679	7.0	10:30	3.00	8.75	
BSB-A1	BSB-GW-02	52.53	0.17	37.47	5531.50	5494.03	7.39	2.8	406	9.9	12:37	10.00	10.00	
BSB-A5	BSB-GW-03	45.60	0.17	45.50	5524.62	5479.12	-	-	-	-	-	-	-	
BSB-A6-R	BSB-GW-04	59.75	0.17	53.13	5554.41	5501.28	6.49	19.7	2279	9.9	10:10	3.31	6.25	
BSB-A6-R	BSB-GW-07	59.75	0.17	53.13	5554.41	5501.28	6.49	19.7	2279	9.9	10:20	3.31	6.25	VOC Duplicate
CLK-1	BSB-GW-05	19.00	0.17	8.40	5478.73	5470.33	6.51	-36.6	1356	9.2	12:50	5.30	8.75	
CLK-2	BSB-GW-06	46.90	0.17	42.39	5511.17	5468.78	7.16	-83.9	1500	9.7	11:37	2.26	7.92	
CLK-1	BSB-GW-08	19.00	0.17	8.40	5478.73	5470.33	6.51	-36.6	1356	9.2	12:57	5.30	8.75	Raw, DM Duplicate
Blank	BSB-GW-09	NA	NA	NA	NA	NA	NA	NA	NA	NA	10:25	NA	NA	Field Blank

KEY:

NA	Measurement Not Taken
SA	Sample Not Taken

FIELD DATA SHEETS & NOTES

4/5/17
Sampling OLD LANDFILL

Calibration of field meters:
pH:
4.00 ⟹ 4.01
7.02 ⟹ 7.00
10.09 ⟹ 10.01
Calibration slope = 93.2 %

Conductivity standard: 1413 µS/cm
Read 1413. avg. cell factor 0.389
ORP @ 18.1 °C ⟹ 425
measured 436.2

T. Armstrong
C. Anderson
> Pioneer

On site @ MBMG-2 @ 920.

Weather: 39°F partly cloudy.
Safety: uneven ground. weather is supposed to get warm - sunscreen if necessary. Pinch points, glass on ground.

DTW: 11.37 ft
TD: 23.25 ft
Column: 11.88 ft
casing diameter: 2 in
pump set @ ~19 ft
3 well volumes: 6 gallons
Start purging @ 0955. 1L/min
using Old landfill 12 volt submersible pump.
Total volume purged: 8.75 gals

Field parameters collected on field data sheet.

Collected BSB-GW-01 @ 1030.

volume	filtered	pres.	analysis
250ml HDPE	↘	HNO_3	dissolved metals
250ml HDPE	-	H_2SO_4	NO_2/NO_3, COD
250ml HDPE	-	NaOH	Cyanide
500ml HDPE	-	-	pH, SC, Cl^-, SO_4^{-2}
3-40ml glass	-	HCl	8260b - VOCs

Arrived @ BSB-A1 @ 1050.
[illegible]
DTW: 37.47 ft
TD: 57.0 ft

VA
~~Colump~~ Column depth: 19.53 ft
casing diameter: 2 in
pump set @: 50 ft
3-well volume 10 gals

using Geopump submersible for sampling collection.

Started purging: 1157 rate of 1L/min
Total Volume purged: 10 gals

Collected field parameters on field data sheet.

Collected **BSB-GW-02** @ 1237

volume	filtered	pres.	analysis
250ml HDPE	–	H_2SO_4	NO_2/NO_3, COD
250ml HDPE	–	NaOH	Cyanide
500ml HDPE	–	–	pH, SC, Cl^-, SO_4^{-2}
3-40ml glass	–	HCl	8260b - VOCs

Arrived @ BSB-A6 @ 1250

DTW: 45.50
TD: 45.60

VA
~~x~~ Column depth: 0.10 ft

Not enough water in the well to sample. ~~No etc~~ Sample not collected.
VA

V Armstrong + C Anderson offsite @ 1345.

4/5/17

4/6/17

GW sampling of OLD LANDFILL

Calibration of field meters.

pH

4.00 → 4.01
7.01 → 7.00
10.05 → 10.01

Conductivity standard 1413 µS/cm
Meter read 1413 µS/cm

ORP @ 18°C ⟹ 425 measured 431.2

Today Activities:
Sample old landfill wells for groundwater.

V. Armstrong
C. Anderson
> P.T.S.

Weather: 47°F ~~partly~~ partly cloudy.
Arrived @ BSB-A6-R @ 0915.

DTW: 53.13 ft
TD: 59.75 ft
Column ~~diameter~~ depth: 6.62 ft

Casing diameter: 2 in
pump set @ ~56 ft.
3-Well Volumes: 3.31 gals

Using geopump submersible for sampling.

Started purging @ 0945 rate of 1L/min.

Collected field parameters on field datasheets. Total volume purged: 6.25 gals

Collected BSB-GW-04 @ 1010.

Volume	Pres.	Analysis
250 ml HDPE	H_2SO_4	NO_2/NO_3, COD
250 ml HDPE	NaOH	Cyanide
500 ml HDPE	—	pH, SC, Cl^-, SO_4^{-2}
3-40 ml glass	HCl	8260b - VOCs:

Duplicate sample collected BSB-GW-07 @ 1020.

3-40 ml glass vials preserved with HCl analysis of 8260b - VOC's.

Arrived @ CLK-2 @ 1100.

DTW: 42.39 ft
TD: 46.90 ft
Column depth: 4.51 ft
casing diameter: 2 in.
pump set @ ~45.5 ft
3-well volume: 2.26 gals

Using a geo pump submersible for water sample collection.

Started 1st purging @ 1112 @ a rate of 38 sec / 1/2 L.

Total volume purged: 7.92 gals

Collected BSB-GW-06 @ 1137.

volume	filtered	pres	analysis
250ml HDPE	X	HNO_3	dissolved metals
500ml HDPE	–	–	pH, SC, Cl⁻, SO_4^{-2}

Field parameters were collected on field data sheet during purging.

Arrived @ CLK-1 @ 1200.

DTW: 8.40 ft (from TOC)
TD: 19.00 ft
Column depth: 10.6 ft
Casing diameter: 2 in
pump is set @ 15 ft
3-Well Volumes: 5.3 gals

Purging began @ 1215 with a geopump submersible at a rate of 1 L/min.
Total volume purged: 8.75 gals
Field parameters were collected and documented on field data sheets.

Collected BSB-GW-05 @ 1250.

volume	filtered	pres.	analysis
250ml HDPE	x	~~HO~~ HNO_3	dissolved metals
500ml HDPE	–	–	pH, Cl⁻, SC, SO_4^{-2}

Collected duplicate sample BSB-GW-08 @ 1257.

250ml HDPE filtered pres. HNO_3 for dissolved metals analysis

500ml HDPE for pH, Cl⁻, SC, SO_4^{-2} analysis.

V. Armstrong + C. Anderson offsite @ 1330.

V Armstrong 4/6/17

4/6/17

2 coolers were sent to Pace Analytical for laboratory analysis via FedEx.

Tracking #s. 7096 3372 6060
7096 3372 6081

4/7/17

Samples arrived @ Pace Analytical in Minneapolis, MN.

4/6/17 -

Field blank was collected and sent to the laboratory analysis.

Collected BSB-GW-09 @ 1410 on 4/6/17.

volume	filtered	pres.	analysis.
250mL HDPE	filtered	HNO_3	dissolved metals
500mL HDPE	–	–	pH, Cl^-, SC, SO_4^{-2}

V Armstrong 4/7/17

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old landfill

WELL/STATION MBMG-2 DATE 4/5/17 TIME 09:20

SAMPLERS VSA/CA WEATHER CONDITIONS 39° F partly cloudy

PHOTO: Yes ______ No X ROLL# ______ NUMBER ______

PURGE DATA:

PURGE METHOD 12 volt SWO pump.

START PURGING 955

PURGE RATE 1L/min ~~GPM~~

RATE CHANGE 1) Time ______ Rate ______

2) Time ______ Rate ______

SAMPLE TIME 1030

WELL DEPTH 23.25 Feet

DEPTH TO WATER 11.37 Feet

COLUMN DEPTH 11.88 Feet

CASING DIAMETER 2 Inch

PUMP SET AT 19 Feet

3 WELL VOLUMES 6 Gallons

TOTAL PURGE VOLUME 8.75 Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-01	250mL	✓	HNO_3	dissolved metals
	250ml		H_2SO_4	NO_2/NO_3, COD
	250ml		NaOH	Cyanide
	500ml		–	pH, SC, Cl^-, SO_4^{-2}
↓	3-40ml		HCl	8260b-VOCs

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
1005		7.0	7.28	676	154.7	4.44
1008		7.0	7.31	678	134.6	4.36
1012		7.0	7.31	678	131.6	4.36
1015		7.0	7.31	679	124.4	4.36
1020		7.0	7.32	679	120.7	4.37

FINAL FIELD PARAMETERS PRIOR TO SAMPLING

FIELD REMARKS: ______

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old landfill

WELL/STATION BSB-A1 DATE 4/5/17 TIME 1050

SAMPLERS VSA/CA WEATHER CONDITIONS 39°F partly cloudy

PHOTO: Yes ______ No X ROLL# ______ NUMBER ______

PURGE DATA:

PURGE METHOD geopump subs

START PURGING 1157

PURGE RATE 1L/min GPM

RATE CHANGE 1) Time ______ Rate ______

2) Time ______ Rate ______

SAMPLE TIME 1237

WELL DEPTH 57.0 Feet

DEPTH TO WATER 37.47 Feet

COLUMN DEPTH 19.53 Feet

CASING DIAMETER 2 Inch

PUMP SET AT 50 Feet

3 WELL VOLUMES 10 Gallons

TOTAL PURGE VOLUME 10 Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-02	250ml		H_2SO_4	NO_2/NO_3, COD
↓	250ml		NaOH	Cyanide
	500ml		–	pH, SC, Cl^-, SO_4^{-2}
	3-40ml		HCl	8260b-VOCs

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
1207		9.9	8.07	406	60.5	0.36
1212		10.0	7.65	401	31.2	0.24
1217		10.0	7.70	397	24.3	0.17
1222		9.9	7.55	397	12.6	0.16
1227		9.9	7.47	403	2.4	0.10
1232		9.9	7.39	406	2.8	0.09
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						

FIELD REMARKS: ______

Pioneer Technical Services

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old landfill

WELL/STATION BSB-A5

DATE 4/5/17

TIME 1250

SAMPLERS —

WEATHER CONDITIONS 39°F partly cloudy

PHOTO: Yes ______ No X

ROLL# ______

NUMBER ______

PURGE DATA:

PURGE METHOD bailer

START PURGING ______

PURGE RATE ______ GPM

RATE CHANGE 1) Time ______ Rate ______

2) Time ______ Rate ______

SAMPLE TIME NONE

WELL DEPTH 45.60 Feet

DEPTH TO WATER 45.50 Feet

COLUMN DEPTH 0.10 Feet

CASING DIAMETER 2 in Inch

PUMP SET AT — Feet

3 WELL VOLUMES ______ Gallons

TOTAL PURGE VOLUME ______ Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-03	—	—	—	NONE

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						

FIELD REMARKS: Well did not have enough water in well to sample.

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old landfill

WELL/STATION BSB-A10 R   DATE 4/6/17   TIME 0915

SAMPLERS JSA/Ct   WEATHER CONDITIONS 41°F partly cloudy

PHOTO: Yes ____ No X   ROLL# ____   NUMBER ____

PURGE DATA:

PURGE METHOD	geopump sub	WELL DEPTH	59.75 Feet
START PURGING	0945	DEPTH TO WATER	53.13 Feet
PURGE RATE	1L/min ~~GPM~~	COLUMN DEPTH	6.62 Feet
RATE CHANGE	1) Time ____ Rate ____	CASING DIAMETER	2 Inch
	2) Time ____ Rate ____	PUMP SET AT	~56 Feet
		3 WELL VOLUMES	3.31 Gallons
SAMPLE TIME	1010	TOTAL PURGE VOLUME	6.25 Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-04	250ml		H_2SO_4	NO_2/NO_3, COD
↓	250ml		NaOH	Cyanide
	500ml		Raw	pH, SC, Cl⁻, SO_4^{-2}
	3-40ml		HCl	8260b-VOCs
BSB-GW-07	3-40ml		HCl	8260b-VOC's

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
0949		9.9	6.48	2291	19.5	0.25
0955		9.9	6.48	2290	20.4	0.24
1000		9.9	6.48	2292	20.9	0.19
1005		9.9	6.49	2289	20.3	0.17
1010		9.9	6.49	2279	19.7	0.16
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						

FIELD REMARKS: duplicate sample collected 3-40ml vials for VOC's @ 1020 BSB-GW-07 preserved with HCl.

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Oldlandfill/~~Gro~~ JEA Clark Tailings

WELL/STATION CLK-1 DATE 4/6/17 TIME 1200

SAMPLERS JEA/CA WEATHER CONDITIONS 41°F partly cloudy

PHOTO: Yes ____ No X ROLL# ____ NUMBER ____

PURGE DATA:

PURGE METHOD GeoSub pump

START PURGING 1215

PURGE RATE 1L/min ~~GPM~~

RATE CHANGE 1) Time ____ Rate ____

2) Time ____ Rate ____

SAMPLE TIME 1250

WELL DEPTH 19.00 Feet

DEPTH TO WATER 8.40 Feet ~~B~~ Top of casing

COLUMN DEPTH 10.6 Feet

CASING DIAMETER 2 Inch

PUMP SET AT 15 Feet

3 WELL VOLUMES 5.3 Gallons

TOTAL PURGE VOLUME 8.75 Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-05	250ml	X	HNO_3	dissolved metals
↓ 500ml	~~250ml~~ JEA		Raw	pH, SC, Cl^-, SO_4^{-2}
BSB-GW-08	250ml	X	HNO_3	dissolved metals
↓ 500ml	~~250ml~~ JEA		Raw	pH, SC, Cl^-, SO_4^{-2}

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
1228		8.6	6.81	1341	62.3	0.07
1233		8.8	6.66	1350	47.7	0.06
1238		9.3	6.59	1350	36.6	0.17
1243		9.4	6.54	1354	-12.2	0.17
1247		9.3	6.52	1356	-27.4	0.06
1250		9.2	6.51	1356	-36.6	0.06
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						

FIELD REMARKS: 1257- BSB-GW-08 duplicate sample collected.

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old landfill / Clark Tailings
WELL/STATION CLK-2
DATE 4/6/17
TIME 1100
SAMPLERS BA/Ct
WEATHER CONDITIONS 41°F partly ~~cloudy~~ cloudy
PHOTO: Yes ______ No X
ROLL# ______
NUMBER ______

PURGE DATA:

PURGE METHOD geopump
START PURGING 1112
PURGE RATE 38 ml/1:22 ~~GPM~~
RATE CHANGE 1) Time ______ Rate ______
2) Time ______ Rate ______
SAMPLE TIME 1137

WELL DEPTH 46.90 Feet
DEPTH TO WATER 42.39 Feet
COLUMN DEPTH 4.51 Feet
CASING DIAMETER 2 Inch
PUMP SET AT ~45.5 Feet
3 WELL VOLUMES 2.26 Gallons
TOTAL PURGE VOLUME 7.92 Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-016	250ml	X	HNO_3	dissolved metals
↓	500ml		–	pH, SC, Cl⁻, SO_4^{-2}

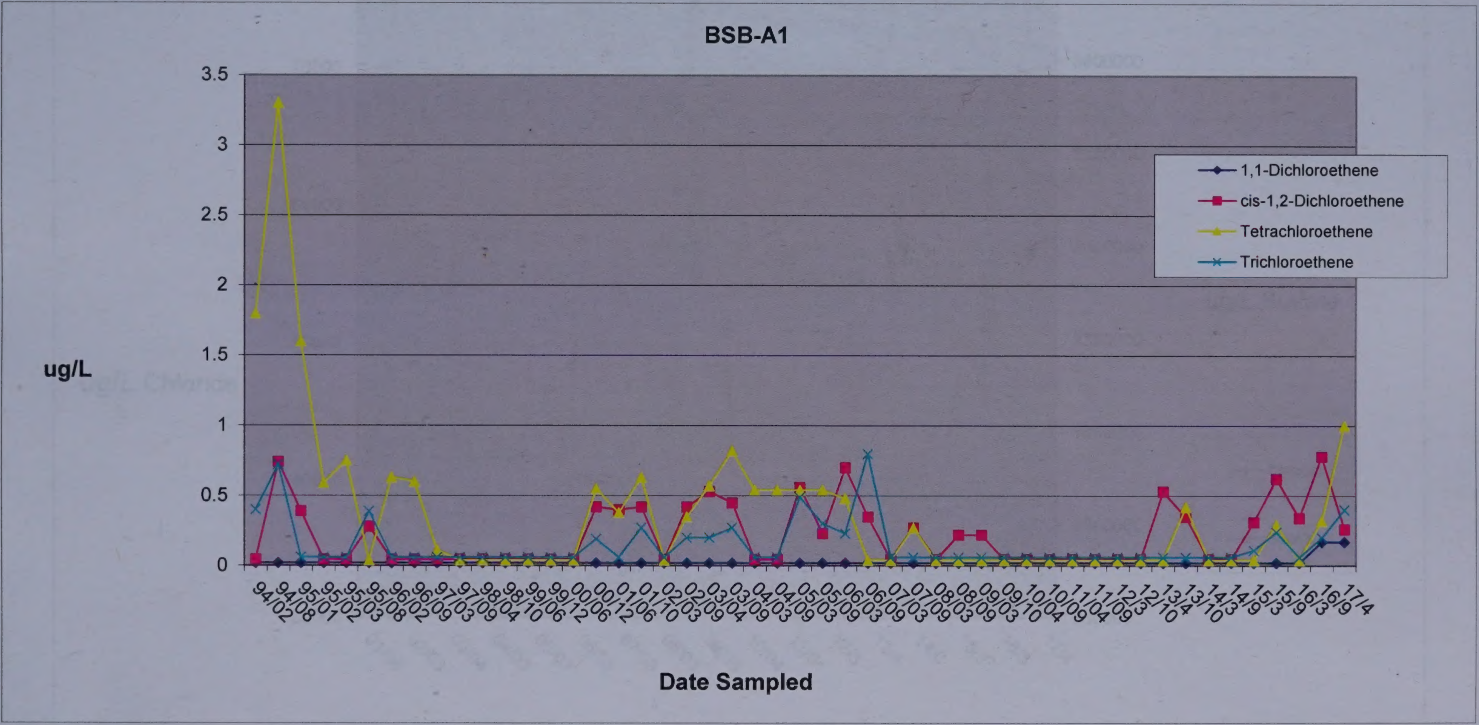
FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
1122		9.2	8.42	1486	13.6	0.40
1127		9.1	7.78	1494	−40.6	0.27
1130		9.1	7.53	1498	−57.9	0.24
1132		9.2	7.20	1499	−77.5	0.21
1136		9.2	7.16	1500	−83.9	0.21

FINAL FIELD PARAMETERS PRIOR TO SAMPLING

FIELD REMARKS: ______

GRAPHS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3
2.5
2
1.5
1
0.5
0
ug/L
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cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
94/02
94/08
95/01
95/02
95/03
95/08
96/02
96/09
97/03
97/09
98/04
98/10
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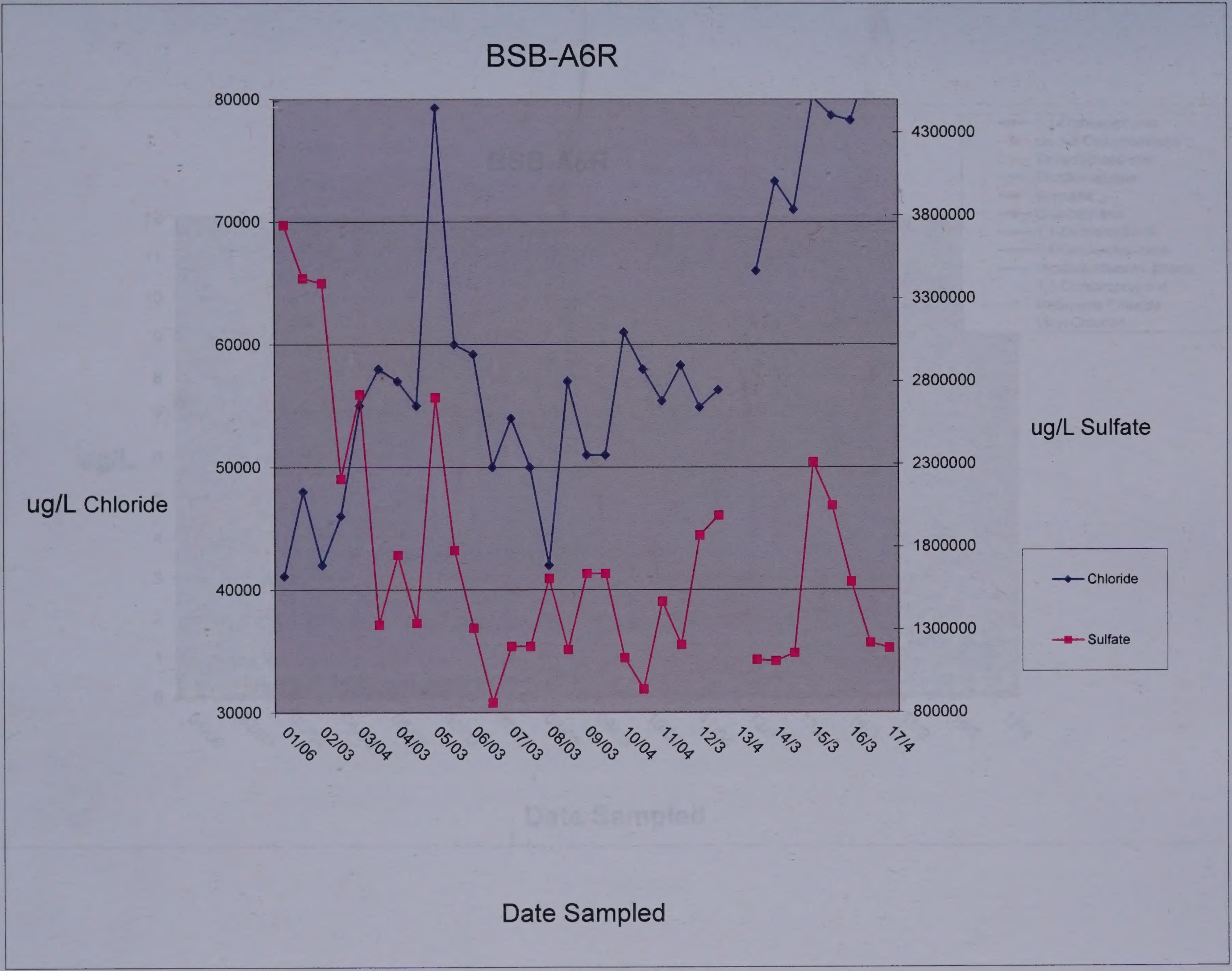
16/3
16/9
17/4
Date Sampled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70000
60000
50000
40000
30000
ug/L Chloride
4300000
3800000
3300000
2800000
2300000
1800000
1300000
800000
ug/L Sulfate
Chloride
Sulfate
01/06
02/03
03/04
04/03
05/03
06/03
07/03
08/03
09/03
10/04
11/04
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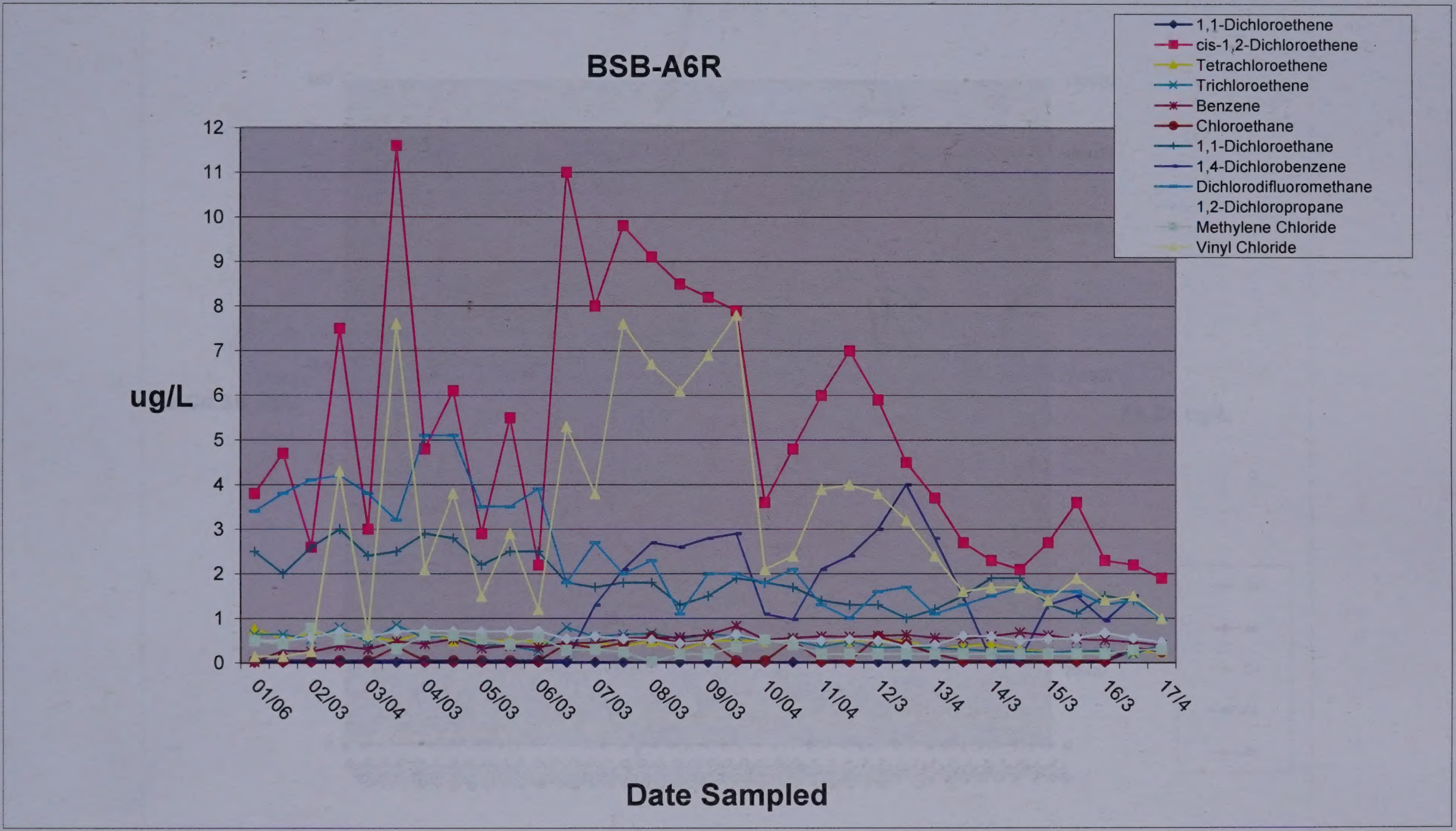
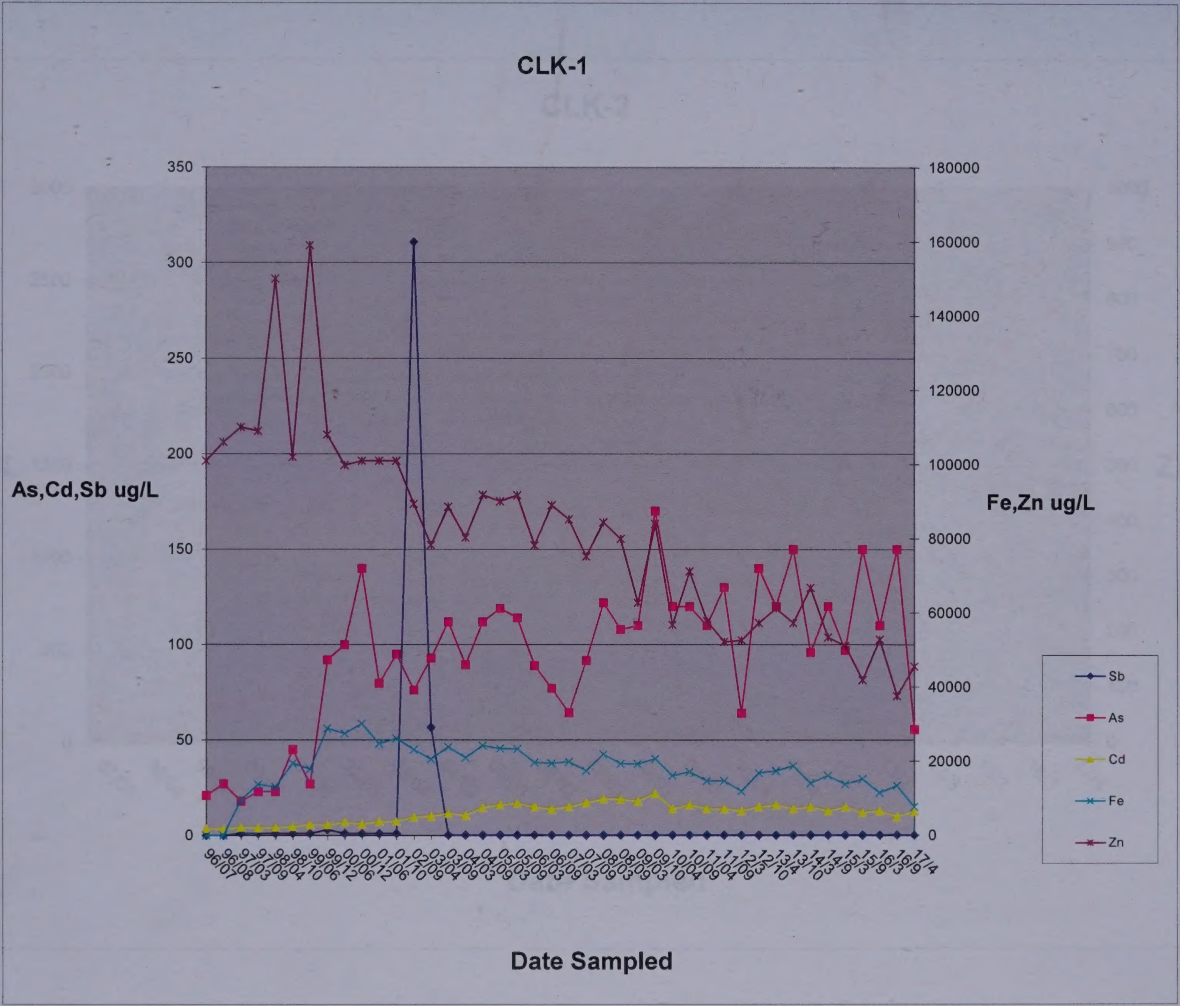
15/3
16/3
17/4
Date Sampled


BSB-A6R
ug/L
12
11
10
9
8
7
6
5
4
3
2
1
0
01/06
02/03
03/04
04/03
05/03
06/03
07/03
08/03
09/03
10/04
11/04
12/3
13/4
14/3
15/3
16/3
17/4
Date Sampled
1,1-Dichloroethene
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Benzene
Chloroethane
1,1-Dichloroethane
1,4-Dichlorobenzene
Dichlorodifluoromethane
1,2-Dichloropropane
Methylene Chloride
Vinyl Chloride


CLK-1
As,Cd,Sb ug/L
Fe,Zn ug/L
0
50
100
150
200
250
300
350
0
20000
40000
60000
80000
100000
120000
140000
160000
180000
96/07
96/08
97/03
97/09
98/04
98/10
99/06
99/12
00/06
00/12
01/06
01/10
02/09
03/04
03/09
04/03
04/09
05/03
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06/09
07/03
07/09
08/03
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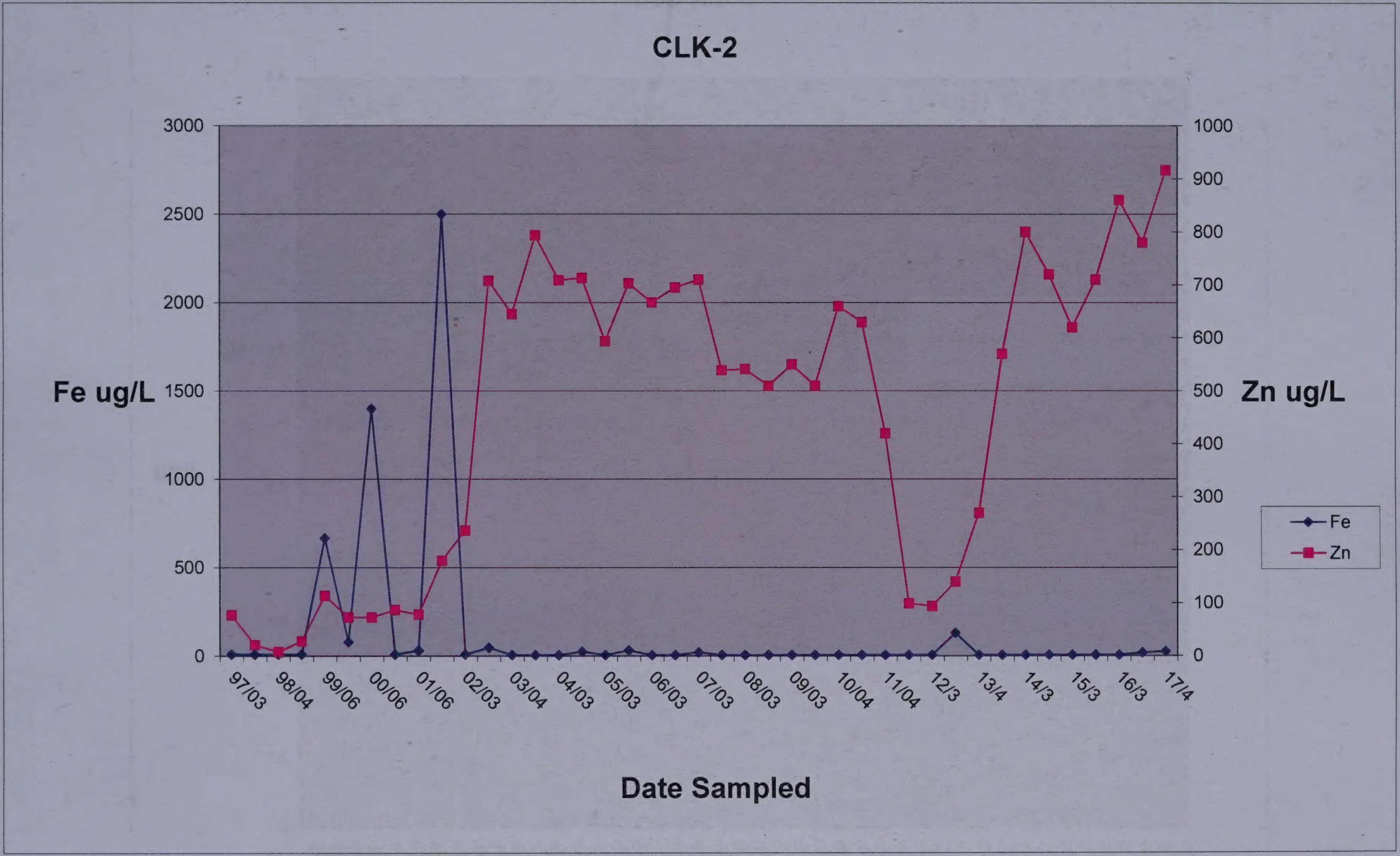
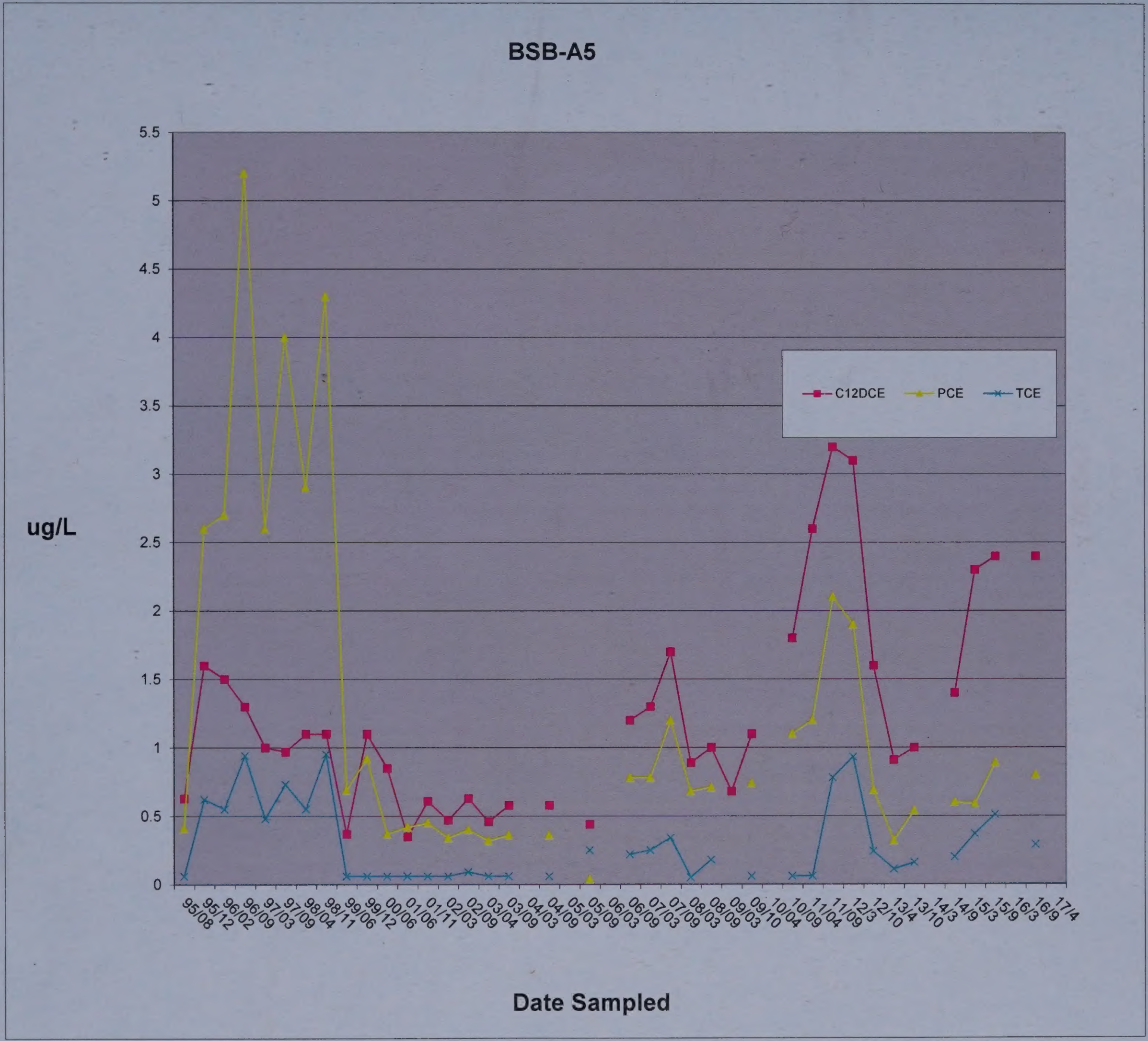
09/03
09/10
10/04
10/09
11/04
11/09
12/3
12/10
13/4
13/10
14/3
14/9
15/3
15/9
16/3
16/9
17/4
Date Sampled
Sb
As
Cd
Fe
Zn


CLK-2
Fe ug/L
Zn ug/L
3000
2500
2000
1500
1000
500
0
1000
900
800
700
600
500
400
300
200
100
0
Fe
Zn
97/03
98/04
99/06
00/06
01/06
02/03
03/04
04/03
05/03
06/03
07/03
08/03
09/03
10/04
11/04
12/3
13/4
14/3
15/3
16/3
17/4
Date Sampled


BSB-A5
ug/L
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
C12DCE
PCE
TCE
95/08
95/12
96/02
96/09
97/03
97/09
98/04
98/11
99/06
99/12
00/06
01/06
01/11
02/03
02/09
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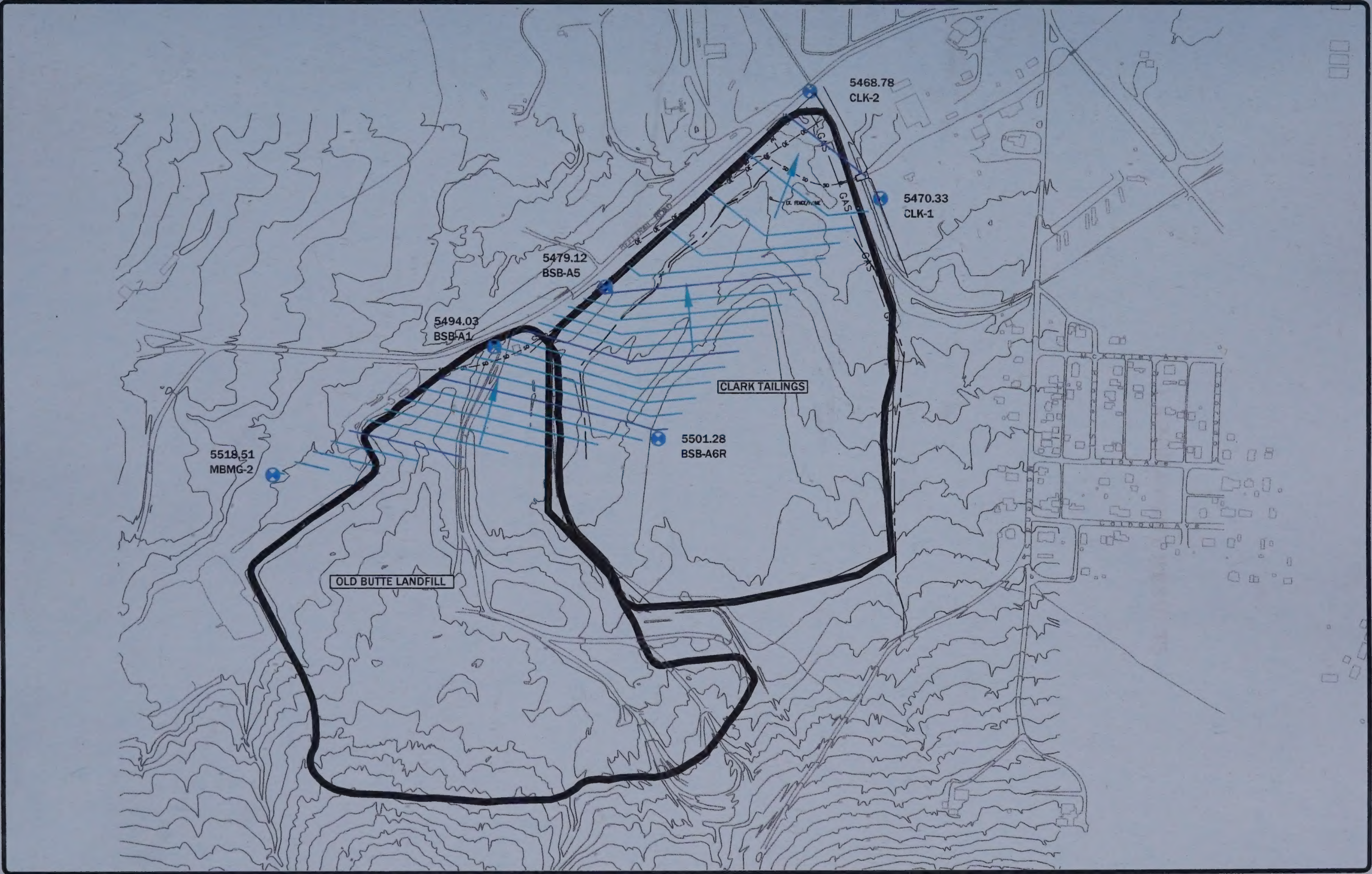
10/09
11/04
11/09
12/3
12/10
13/4
13/10
14/3
14/9
15/3
15/9
16/3
16/9
17/4
Date Sampled

FIGURES


5468.78
CLK-2
5470.33
CLK-1
GAS
BEEFTRAIL ROAD
5479.12
BSB-A5
5494.03
BSB-A1
CLARK TAILINGS
5501.28
BSB-A6R
5518.51
MBMG-2
OLD BUTTE LANDFILL

LEGEND

CLK-1 ●	MONITORING WELL
——	CONTOUR

CONTOUR INTERVAL= 10'

N

DISPLAYED AS:
COORD SYS/ZONE: NA
DATUM: NA
UNITS: FEET
SOURCE: PIONEER

SCALE IN FEET
0 300 600

FIGURE 1

PIONEER
TECHNICAL SERVICES, INC.
63-1/2 WEST BROADWAY
BUTTE, MONTANA 59701
(406) 782-5177

OLD MUNICIPAL LANDFILL SITE/CLARK TAILINGS FACILITY APRIL 2017

DATE: 6/2017

5/31/2017 8:15:48 AM P:\BUTTE-SILVER BOW\BSB OLD LANDFILL\OLD LANDFILL\2017\OLDLNDFL-FG-PLN-001-17.DWG

LABORATORY RESULTS

www.pacelabs.com

Pace Analytical Services, LLC
1700 Elm Street - Suite 200
Minneapolis, MN 55414
(612)607-1700

April 21, 2017

Vanessa Armstrong
Pioneer Technical Services
1101 S. Montana Street
Butte, MT 59701

RE: Project: Old Landfill
Pace Project No.: 10384255

Dear Vanessa Armstrong:

Enclosed are the analytical results for sample(s) received by the laboratory on April 07, 2017. The results relate only to the samples included in this report. Results reported herein conform to the most current, applicable TNI/NELAC standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Bob Michels
bob.michels@pacelabs.com
(612)607-6452
Project Manager

Enclosures

cc: Julie Flammang, Pioneer Technical
Brad Hollamon, Pioneer Technical Services

CERTIFICATIONS

Project: Old Landfill
Pace Project No.: 10384255

Minnesota Certification IDs

1700 Elm Street SE, Suite 200, Minneapolis, MN 55414
A2LA Certification #: 2926.01
Alabama Certification #: 40770
Alaska Contaminated Sites Certification #: UST-078
Alaska DW Certification #: MN00064
Arizona Certification #: AZ0014
Arkansas Certification #: 88-0680
California Certification #: MN00064
CNMI Saipan Certification #:MP0003
Colorado Certification #: MN00064
Connecticut Certification #: PH-0256
EPA Region 8 Certification #: 8TMS-L
Florida Certification #: E87605
Georgia Certification #: 959
Guam EPA Certification #: MN00064
Hawaii Certification #: MN00064
Idaho Certification #: MN00064
Illinois Certification #: 200011
Indiana Certification #: C-MN-01
Iowa Certification #: 368
Kansas Certification #: E-10167
Kentucky DW Certification #: 90062
Kentucky WW Certification #: 90062
Louisiana DEQ Certification #: 03086
Louisiana DW Certification #: MN00064
Maine Certification #: MN00064
Maryland Certification #: 322
Michigan Certification #: 9909
Minnesota Certification #: 027-053-137
Mississippi Certification #: MN00064
Montana Certification #: CERT0092
Nebraska Certification #: NE-OS-18-06
Nevada Certification #: MN00064
New Hampshire Certification #: 2081
New Jersey Certification #: MN002
New York Certification #: 11647
North Carolina DW Certification #: 27700
North Carolina WW Certification #: 530
North Dakota Certification #: R-036
Ohio DW Certification #: 41244
Ohio VAP Certification #: CL101
Oklahoma Certification #: 9507
Oregon NwTPH Certification #: MN300001
Oregon Secondary Certification #: MN200001
Pennsylvania Certification #: 68-00563
Puerto Rico Certification #: MN00064
South Carolina Certification #:74003001
Tennessee Certification #: TN02818
Texas Certification #: T104704192
Utah Certification #: MN00064
Virginia Certification #: 460163
Washington Certification #: C486
West Virginia DW Certification #: 9952 C
West Virginia WW Certification #: 382
Wisconsin Certification #: 999407970
Wyoming via EPA Region 8 Certification #: 8TMS-L

SAMPLE SUMMARY

Project: Old Landfill
Pace Project No.: 10384255

Lab ID	Sample ID	Matrix	Date Collected	Date Received
10384255001	**BSB-GW-01**	Water	04/05/17 10:30	04/07/17 09:45
10384255002	**BSB-GW-02**	Water	04/05/17 12:37	04/07/17 09:45
10384255003	**BSB-GW-04**	Water	04/06/17 09:45	04/07/17 09:45
10384255004	**BSB-GW-07**	Water	04/06/17 10:20	04/07/17 09:45
10384255005	**Trip Blank**	Water	04/05/17 00:00	04/07/17 09:45

SAMPLE ANALYTE COUNT

Project: Old Landfill
Pace Project No.: 10384255

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
10384255001	**BSB-GW-01**	EPA 200.8	TT3	14	PASI-M
		EPA 8260B	DJB	53	PASI-M
		EPA 120.1	AJS	1	PASI-M
		SM 4500-H+B	AR3	1	PASI-M
		EPA 410.4	DCL	1	PASI-M
		SM 4500-NO3 H	DCL	1	PASI-M
		ASTM D516	JFP	1	PASI-M
		SM 4500-Cl E	JFP	1	PASI-M
		SM 4500-CN-E	DCL	1	PASI-M
10384255002	**BSB-GW-02**	EPA 8260B	DJB	53	PASI-M
		EPA 120.1	AJS	1	PASI-M
		SM 4500-H+B	AR3	1	PASI-M
		EPA 410.4	DCL	1	PASI-M
		SM 4500-NO3 H	DCL	1	PASI-M
		ASTM D516	JFP	1	PASI-M
		SM 4500-Cl E	JFP	1	PASI-M
		SM 4500-CN-E	DCL	1	PASI-M
10384255003	**BSB-GW-04**	EPA 8260B	DJB	53	PASI-M
		EPA 120.1	AJS	1	PASI-M
		SM 4500-H+B	AR3	1	PASI-M
		EPA 410.4	DCL	1	PASI-M
		SM 4500-NO3 H	DCL	1	PASI-M
		ASTM D516	JFP	1	PASI-M
		SM 4500-Cl E	JFP	1	PASI-M
		SM 4500-CN-E	DCL	1	PASI-M
10384255004	**BSB-GW-07**	EPA 8260B	DJB	53	PASI-M
10384255005	**Trip Blank**	EPA 8260B	DJB	53	PASI-M

PROJECT NARRATIVE

Project:	Old Landfill
Pace Project No.:	10384255

Method: EPA 200.8
Description: 200.8 MET ICPMS, Dissolved
Client: Pioneer Technical
Date: April 21, 2017

General Information:
1 sample was analyzed for EPA 200.8. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 200.8 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Internal Standards:
All internal standards were within QC limits with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

QC Batch: 467722

B: Analyte was detected in the associated method blank.

- BLANK for HBN 467722 [MPRP/712 (Lab ID: 2555322)
  - Lead, Dissolved

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project: Old Landfill
Pace Project No.: 10384255

Method: **EPA 8260B**
Description: 8260B MSV
Client: Pioneer Technical
Date: April 21, 2017

General Information:
5 samples were analyzed for EPA 8260B. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Internal Standards:
All internal standards were within QC limits with any exceptions noted below.

Surrogates:
All surrogates were within QC limits with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 468508

A matrix spike/matrix spike duplicate was not performed due to insufficient sample volume.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project:	Old Landfill
Pace Project No.:	10384255

Method: EPA 120.1
Description: 120.1 Specific Conductance
Client: Pioneer Technical
Date: April 21, 2017

General Information:
3 samples were analyzed for EPA 120.1. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project:	Old Landfill
Pace Project No.:	10384255

Method: **SM 4500-H+B**
Description: 4500H+ pH, Electrometric
Client: Pioneer Technical
Date: April 21, 2017

General Information:
3 samples were analyzed for SM 4500-H+B. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

H6: Analysis initiated outside of the 15 minute EPA required holding time.
- BSB-GW-01 (Lab ID: 10384255001)
- BSB-GW-02 (Lab ID: 10384255002)
- BSB-GW-04 (Lab ID: 10384255003)

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project: Old Landfill
Pace Project No.: 10384255

Method: EPA 410.4
Description: 410.4 COD
Client: Pioneer Technical
Date: April 21, 2017

General Information:
3 samples were analyzed for EPA 410.4. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 410.4 with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project:	Old Landfill
Pace Project No.:	10384255

Method: **SM 4500-NO3 H**
Description: SM4500NO3-H, NO2 + NO3 pres.
Client: Pioneer Technical
Date: April 21, 2017

General Information:
3 samples were analyzed for SM 4500-NO3 H. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 468578

A matrix spike and/or matrix spike duplicate (MS/MSD) were performed on the following sample(s): 10384646001,10384646002

M1: Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.

- MS (Lab ID: 2559165)
  - Nitrogen, NO2 plus NO3
- MS (Lab ID: 2559167)
  - Nitrogen, NO2 plus NO3
- MSD (Lab ID: 2559166)
  - Nitrogen, NO2 plus NO3
- MSD (Lab ID: 2559168)
  - Nitrogen, NO2 plus NO3

Additional Comments:

PROJECT NARRATIVE

Project:	Old Landfill
Pace Project No.:	10384255

Method: **ASTM D516**
Description: ASTM D516 Sulfate Water
Client: Pioneer Technical
Date: April 21, 2017

General Information:
3 samples were analyzed for ASTM D516. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 468337

A matrix spike and/or matrix spike duplicate (MS/MSD) were performed on the following sample(s): 10383897001,10384466004

M1: Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.

- MSD (Lab ID: 2557796)
  - Sulfate

Additional Comments:

PROJECT NARRATIVE

Project: Old Landfill
Pace Project No.: 10384255

Method: **SM 4500-Cl E**
Description: SM4500Cl-E Chloride
Client: Pioneer Technical
Date: April 21, 2017

General Information:
3 samples were analyzed for SM 4500-Cl E. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 468013

A matrix spike and/or matrix spike duplicate (MS/MSD) were performed on the following sample(s): 10383767003,10384255002

M1: Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.

- MS (Lab ID: 2556260)
  - Chloride
- MS (Lab ID: 2556262)
  - Chloride
- MSD (Lab ID: 2556261)
  - Chloride
- MSD (Lab ID: 2556263)
  - Chloride

Additional Comments:

PROJECT NARRATIVE

Project:	Old Landfill
Pace Project No.:	10384255

Method: **SM 4500-CN-E**
Description: SM4500CN-E Cyanide
Client: Pioneer Technical
Date: April 21, 2017

General Information:
3 samples were analyzed for SM 4500-CN-E. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with SM 4500-CN-E with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

This data package has been reviewed for quality and completeness and is approved for release.

ANALYTICAL RESULTS

Project: Old Landfill
Pace Project No.: 10384255

Sample: BSB-GW-01 **Lab ID: 10384255001** Collected: 04/05/17 10:30 Received: 04/07/17 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Antimony, Dissolved	**0.25J**	ug/L	0.50	0.032	1	04/10/17 10:43	04/11/17 11:48	7440-36-0	
Arsenic, Dissolved	**1.3**	ug/L	0.50	0.091	1	04/10/17 10:43	04/11/17 11:48	7440-38-2	
Barium, Dissolved	**134**	ug/L	0.30	0.019	1	04/10/17 10:43	04/11/17 11:48	7440-39-3	
Beryllium, Dissolved	ND	ug/L	0.20	0.030	1	04/10/17 10:43	04/11/17 11:48	7440-41-7	
Cadmium, Dissolved	**0.013J**	ug/L	0.080	0.013	1	04/10/17 10:43	04/11/17 11:48	7440-43-9	
Chromium, Dissolved	**0.83**	ug/L	0.50	0.14	1	04/10/17 10:43	04/11/17 11:48	7440-47-3	
Cobalt, Dissolved	**0.24J**	ug/L	0.50	0.021	1	04/10/17 10:43	04/11/17 11:48	7440-48-4	
Copper, Dissolved	**1.1**	ug/L	1.0	0.40	1	04/10/17 10:43	04/11/17 11:48	7440-50-8	
Iron, Dissolved	ND	ug/L	50.0	18.5	1	04/10/17 10:43	04/11/17 11:48	7439-89-6	
Lead, Dissolved	**0.016J**	ug/L	0.10	0.012	1	04/10/17 10:43	04/11/17 11:48	7439-92-1	B
Nickel, Dissolved	**0.22J**	ug/L	0.50	0.099	1	04/10/17 10:43	04/11/17 11:48	7440-02-0	
Selenium, Dissolved	**1.0**	ug/L	0.50	0.13	1	04/10/17 10:43	04/11/17 11:48	7782-49-2	
Vanadium, Dissolved	**7.1**	ug/L	1.0	0.085	1	04/10/17 10:43	04/11/17 11:48	7440-62-2	
Zinc, Dissolved	**3.1J**	ug/L	5.0	0.78	1	04/10/17 10:43	04/11/17 11:48	7440-66-6	
8260B MSV	Analytical Method: EPA 8260B								
Acetone	**7.7J**	ug/L	20.0	2.0	1		04/14/17 01:26	67-64-1	
Acrylonitrile	ND	ug/L	10.0	0.49	1		04/14/17 01:26	107-13-1	
Benzene	**0.36J**	ug/L	1.0	0.16	1		04/14/17 01:26	71-43-2	
Bromochloromethane	ND	ug/L	1.0	0.19	1		04/14/17 01:26	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.24	1		04/14/17 01:26	75-27-4	
Bromoform	ND	ug/L	4.0	0.27	1		04/14/17 01:26	75-25-2	
Bromomethane	ND	ug/L	10.0	0.44	1		04/14/17 01:26	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		04/14/17 01:26	78-93-3	
Carbon disulfide	ND	ug/L	1.0	0.30	1		04/14/17 01:26	75-15-0	
Carbon tetrachloride	ND	ug/L	1.0	0.20	1		04/14/17 01:26	56-23-5	
Chlorobenzene	ND	ug/L	1.0	0.11	1		04/14/17 01:26	108-90-7	
Chloroethane	ND	ug/L	1.0	0.34	1		04/14/17 01:26	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		04/14/17 01:26	67-66-3	
Chloromethane	ND	ug/L	4.0	0.25	1		04/14/17 01:26	74-87-3	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		04/14/17 01:26	96-12-8	
Dibromochloromethane	ND	ug/L	1.0	0.16	1		04/14/17 01:26	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.20	1		04/14/17 01:26	106-93-4	
Dibromomethane	ND	ug/L	4.0	0.19	1		04/14/17 01:26	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	1.0	0.17	1		04/14/17 01:26	95-50-1	
1,4-Dichlorobenzene	ND	ug/L	1.0	0.21	1		04/14/17 01:26	106-46-7	
trans-1,4-Dichloro-2-butene	ND	ug/L	10.0	0.45	1		04/14/17 01:26	110-57-6	
Dichlorodifluoromethane	ND	ug/L	1.0	0.23	1		04/14/17 01:26	75-71-8	
1,1-Dichloroethane	ND	ug/L	1.0	0.17	1		04/14/17 01:26	75-34-3	
1,2-Dichloroethane	ND	ug/L	1.0	0.17	1		04/14/17 01:26	107-06-2	
1,1-Dichloroethene	ND	ug/L	1.0	0.28	1		04/14/17 01:26	75-35-4	
cis-1,2-Dichloroethene	ND	ug/L	1.0	0.12	1		04/14/17 01:26	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	1.0	0.16	1		04/14/17 01:26	156-60-5	
1,2-Dichloropropane	ND	ug/L	4.0	0.22	1		04/14/17 01:26	78-87-5	
cis-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		04/14/17 01:26	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		04/14/17 01:26	10061-02-6	

ANALYTICAL RESULTS

Project: Old Landfill
Pace Project No.: 10384255

Sample: BSB-GW-01 **Lab ID: 10384255001** Collected: 04/05/17 10:30 Received: 04/07/17 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Ethylbenzene	ND	ug/L	1.0	0.15	1		04/14/17 01:26	100-41-4	
2-Hexanone	ND	ug/L	5.0	0.19	1		04/14/17 01:26	591-78-6	
Iodomethane	ND	ug/L	4.0	0.18	1		04/14/17 01:26	74-88-4	
Methylene Chloride	ND	ug/L	4.0	0.29	1		04/14/17 01:26	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.43	1		04/14/17 01:26	108-10-1	
Styrene	ND	ug/L	1.0	0.29	1		04/14/17 01:26	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	0.17	1		04/14/17 01:26	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0	0.22	1		04/14/17 01:26	79-34-5	
Tetrachloroethene	ND	ug/L	1.0	0.25	1		04/14/17 01:26	127-18-4	
Toluene	ND	ug/L	1.0	0.14	1		04/14/17 01:26	108-88-3	
1,1,1-Trichloroethane	ND	ug/L	1.0	0.17	1		04/14/17 01:26	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	1.0	0.15	1		04/14/17 01:26	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.052	1		04/14/17 01:26	79-01-6	
Trichlorofluoromethane	ND	ug/L	1.0	0.33	1		04/14/17 01:26	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.28	1		04/14/17 01:26	96-18-4	
Vinyl acetate	ND	ug/L	10.0	0.12	1		04/14/17 01:26	108-05-4	
Vinyl chloride	ND	ug/L	0.20	0.069	1		04/14/17 01:26	75-01-4	
Xylene (Total)	ND	ug/L	3.0	0.32	1		04/14/17 01:26	1330-20-7	
m&p-Xylene	ND	ug/L	2.0	0.11	1		04/14/17 01:26	179601-23-1	
o-Xylene	ND	ug/L	1.0	0.20	1		04/14/17 01:26	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	102	%.	75-137		1		04/14/17 01:26	17060-07-0	
Toluene-d8 (S)	93	%.	75-125		1		04/14/17 01:26	2037-26-5	
4-Bromofluorobenzene (S)	95	%.	75-125		1		04/14/17 01:26	460-00-4	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**765**	umhos/cm	1.0	1.0	1		04/17/17 10:34		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**7.1**	Std. Units	0.10	0.10	1		04/20/17 16:17		H6
410.4 COD	Analytical Method: EPA 410.4 Preparation Method: EPA 410.4								
Chemical Oxygen Demand	ND	mg/L	50.0	5.4	1	04/11/17 09:12	04/11/17 12:44		
SM4500NO3-H, NO2 + NO3 pres.	Analytical Method: SM 4500-NO3 H								
Nitrogen, NO2 plus NO3	**3.8**	mg/L	0.10	0.050	1		04/14/17 09:18		
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**129**	mg/L	12.5	5.2	5		04/13/17 15:39	14808-79-8	
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	**57.2**	mg/L	2.0	0.90	2		04/11/17 13:51	16887-00-6	
SM4500CN-E Cyanide	Analytical Method: SM 4500-CN-E Preparation Method: SM 4500-CN-E								
Cyanide	ND	ug/L	10.0	4.2	1	04/17/17 11:11	04/17/17 14:20	57-12-5	

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ANALYTICAL RESULTS

Project: Old Landfill
Pace Project No.: 10384255

Sample: BSB-GW-02 **Lab ID: 10384255002** Collected: 04/05/17 12:37 Received: 04/07/17 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Acetone	**4.4J**	ug/L	20.0	2.0	1		04/14/17 01:48	67-64-1	
Acrylonitrile	ND	ug/L	10.0	0.49	1		04/14/17 01:48	107-13-1	
Benzene	**0.18J**	ug/L	1.0	0.16	1		04/14/17 01:48	71-43-2	
Bromochloromethane	ND	ug/L	1.0	0.19	1		04/14/17 01:48	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.24	1		04/14/17 01:48	75-27-4	
Bromoform	ND	ug/L	4.0	0.27	1		04/14/17 01:48	75-25-2	
Bromomethane	ND	ug/L	10.0	0.44	1		04/14/17 01:48	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		04/14/17 01:48	78-93-3	
Carbon disulfide	ND	ug/L	1.0	0.30	1		04/14/17 01:48	75-15-0	
Carbon tetrachloride	ND	ug/L	1.0	0.20	1		04/14/17 01:48	56-23-5	
Chlorobenzene	ND	ug/L	1.0	0.11	1		04/14/17 01:48	108-90-7	
Chloroethane	ND	ug/L	1.0	0.34	1		04/14/17 01:48	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		04/14/17 01:48	67-66-3	
Chloromethane	ND	ug/L	4.0	0.25	1		04/14/17 01:48	74-87-3	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		04/14/17 01:48	96-12-8	
Dibromochloromethane	ND	ug/L	1.0	0.16	1		04/14/17 01:48	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.20	1		04/14/17 01:48	106-93-4	
Dibromomethane	ND	ug/L	4.0	0.19	1		04/14/17 01:48	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	1.0	0.17	1		04/14/17 01:48	95-50-1	
1,4-Dichlorobenzene	ND	ug/L	1.0	0.21	1		04/14/17 01:48	106-46-7	
trans-1,4-Dichloro-2-butene	ND	ug/L	10.0	0.45	1		04/14/17 01:48	110-57-6	
Dichlorodifluoromethane	ND	ug/L	1.0	0.23	1		04/14/17 01:48	75-71-8	
1,1-Dichloroethane	ND	ug/L	1.0	0.17	1		04/14/17 01:48	75-34-3	
1,2-Dichloroethane	ND	ug/L	1.0	0.17	1		04/14/17 01:48	107-06-2	
1,1-Dichloroethene	ND	ug/L	1.0	0.28	1		04/14/17 01:48	75-35-4	
cis-1,2-Dichloroethene	**0.26J**	ug/L	1.0	0.12	1		04/14/17 01:48	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	1.0	0.16	1		04/14/17 01:48	156-60-5	
1,2-Dichloropropane	ND	ug/L	4.0	0.22	1		04/14/17 01:48	78-87-5	
cis-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		04/14/17 01:48	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		04/14/17 01:48	10061-02-6	
Ethylbenzene	ND	ug/L	1.0	0.15	1		04/14/17 01:48	100-41-4	
2-Hexanone	ND	ug/L	5.0	0.19	1		04/14/17 01:48	591-78-6	
Iodomethane	ND	ug/L	4.0	0.18	1		04/14/17 01:48	74-88-4	
Methylene Chloride	ND	ug/L	4.0	0.29	1		04/14/17 01:48	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.43	1		04/14/17 01:48	108-10-1	
Styrene	ND	ug/L	1.0	0.29	1		04/14/17 01:48	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	0.17	1		04/14/17 01:48	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0	0.22	1		04/14/17 01:48	79-34-5	
Tetrachloroethene	ND	ug/L	1.0	0.25	1		04/14/17 01:48	127-18-4	
Toluene	ND	ug/L	1.0	0.14	1		04/14/17 01:48	108-88-3	
1,1,1-Trichloroethane	ND	ug/L	1.0	0.17	1		04/14/17 01:48	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	1.0	0.15	1		04/14/17 01:48	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.052	1		04/14/17 01:48	79-01-6	
Trichlorofluoromethane	ND	ug/L	1.0	0.33	1		04/14/17 01:48	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.28	1		04/14/17 01:48	96-18-4	
Vinyl acetate	ND	ug/L	10.0	0.12	1		04/14/17 01:48	108-05-4	

ANALYTICAL RESULTS

Project: Old Landfill
Pace Project No.: 10384255

Sample: BSB-GW-02 **Lab ID: 10384255002** Collected: 04/05/17 12:37 Received: 04/07/17 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Vinyl chloride	ND	ug/L	0.20	0.069	1		04/14/17 01:48	75-01-4	
Xylene (Total)	ND	ug/L	3.0	0.32	1		04/14/17 01:48	1330-20-7	
m&p-Xylene	**0.51J**	ug/L	2.0	0.11	1		04/14/17 01:48	179601-23-1	
o-Xylene	**0.28J**	ug/L	1.0	0.20	1		04/14/17 01:48	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	105	%.	75-137		1		04/14/17 01:48	17060-07-0	
Toluene-d8 (S)	93	%.	75-125		1		04/14/17 01:48	2037-26-5	
4-Bromofluorobenzene (S)	94	%.	75-125		1		04/14/17 01:48	460-00-4	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**482**	umhos/cm	1.0	1.0	1		04/17/17 10:36		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**7.0**	Std. Units	0.10	0.10	1		04/20/17 16:17		H6
410.4 COD	Analytical Method: EPA 410.4 Preparation Method: EPA 410.4								
Chemical Oxygen Demand	**19.0J**	mg/L	50.0	5.4	1	04/11/17 09:12	04/11/17 12:44		
SM4500NO3-H, NO2 + NO3 pres.	Analytical Method: SM 4500-NO3 H								
Nitrogen, NO2 plus NO3	**0.27**	mg/L	0.10	0.050	1		04/14/17 09:19		
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**73.7**	mg/L	12.5	5.2	5		04/13/17 16:00	14808-79-8	
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	**19.6**	mg/L	1.0	0.45	1		04/11/17 13:12	16887-00-6	M1
SM4500CN-E Cyanide	Analytical Method: SM 4500-CN-E Preparation Method: SM 4500-CN-E								
Cyanide	ND	ug/L	10.0	4.2	1	04/17/17 11:11	04/17/17 14:20	57-12-5	

ANALYTICAL RESULTS

Project: Old Landfill
Pace Project No.: 10384255

Sample: BSB-GW-04 **Lab ID: 10384255003** Collected: 04/06/17 09:45 Received: 04/07/17 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Acetone	**5.4J**	ug/L	20.0	2.0	1		04/14/17 02:10	67-64-1	
Acrylonitrile	ND	ug/L	10.0	0.49	1		04/14/17 02:10	107-13-1	
Benzene	**0.39J**	ug/L	1.0	0.16	1		04/14/17 02:10	71-43-2	
Bromochloromethane	ND	ug/L	1.0	0.19	1		04/14/17 02:10	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.24	1		04/14/17 02:10	75-27-4	
Bromoform	ND	ug/L	4.0	0.27	1		04/14/17 02:10	75-25-2	
Bromomethane	ND	ug/L	10.0	0.44	1		04/14/17 02:10	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		04/14/17 02:10	78-93-3	
Carbon disulfide	ND	ug/L	1.0	0.30	1		04/14/17 02:10	75-15-0	
Carbon tetrachloride	ND	ug/L	1.0	0.20	1		04/14/17 02:10	56-23-5	
Chlorobenzene	ND	ug/L	1.0	0.11	1		04/14/17 02:10	108-90-7	
Chloroethane	ND	ug/L	1.0	0.34	1		04/14/17 02:10	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		04/14/17 02:10	67-66-3	
Chloromethane	ND	ug/L	4.0	0.25	1		04/14/17 02:10	74-87-3	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		04/14/17 02:10	96-12-8	
Dibromochloromethane	ND	ug/L	1.0	0.16	1		04/14/17 02:10	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.20	1		04/14/17 02:10	106-93-4	
Dibromomethane	ND	ug/L	4.0	0.19	1		04/14/17 02:10	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	1.0	0.17	1		04/14/17 02:10	95-50-1	
1,4-Dichlorobenzene	**0.96J**	ug/L	1.0	0.21	1		04/14/17 02:10	106-46-7	
trans-1,4-Dichloro-2-butene	ND	ug/L	10.0	0.45	1		04/14/17 02:10	110-57-6	
Dichlorodifluoromethane	**0.99J**	ug/L	1.0	0.23	1		04/14/17 02:10	75-71-8	
1,1-Dichloroethane	**1.1**	ug/L	1.0	0.17	1		04/14/17 02:10	75-34-3	
1,2-Dichloroethane	ND	ug/L	1.0	0.17	1		04/14/17 02:10	107-06-2	
1,1-Dichloroethene	ND	ug/L	1.0	0.28	1		04/14/17 02:10	75-35-4	
cis-1,2-Dichloroethene	**1.9**	ug/L	1.0	0.12	1		04/14/17 02:10	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	1.0	0.16	1		04/14/17 02:10	156-60-5	
1,2-Dichloropropane	**0.46J**	ug/L	4.0	0.22	1		04/14/17 02:10	78-87-5	
cis-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		04/14/17 02:10	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		04/14/17 02:10	10061-02-6	
Ethylbenzene	ND	ug/L	1.0	0.15	1		04/14/17 02:10	100-41-4	
2-Hexanone	ND	ug/L	5.0	0.19	1		04/14/17 02:10	591-78-6	
Iodomethane	ND	ug/L	4.0	0.18	1		04/14/17 02:10	74-88-4	
Methylene Chloride	ND	ug/L	4.0	0.29	1		04/14/17 02:10	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.43	1		04/14/17 02:10	108-10-1	
Styrene	ND	ug/L	1.0	0.29	1		04/14/17 02:10	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	0.17	1		04/14/17 02:10	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0	0.22	1		04/14/17 02:10	79-34-5	
Tetrachloroethene	ND	ug/L	1.0	0.25	1		04/14/17 02:10	127-18-4	
Toluene	ND	ug/L	1.0	0.14	1		04/14/17 02:10	108-88-3	
1,1,1-Trichloroethane	ND	ug/L	1.0	0.17	1		04/14/17 02:10	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	1.0	0.15	1		04/14/17 02:10	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.052	1		04/14/17 02:10	79-01-6	
Trichlorofluoromethane	ND	ug/L	1.0	0.33	1		04/14/17 02:10	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.28	1		04/14/17 02:10	96-18-4	
Vinyl acetate	ND	ug/L	10.0	0.12	1		04/14/17 02:10	108-05-4	

ANALYTICAL RESULTS

Project: Old Landfill
Pace Project No.: 10384255

Sample: BSB-GW-04 **Lab ID: 10384255003** Collected: 04/06/17 09:45 Received: 04/07/17 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Vinyl chloride	**1.0**	ug/L	0.20	0.069	1		04/14/17 02:10	75-01-4	
Xylene (Total)	ND	ug/L	3.0	0.32	1		04/14/17 02:10	1330-20-7	
m&p-Xylene	**0.52J**	ug/L	2.0	0.11	1		04/14/17 02:10	179601-23-1	
o-Xylene	**0.28J**	ug/L	1.0	0.20	1		04/14/17 02:10	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	103	%.	75-137		1		04/14/17 02:10	17060-07-0	
Toluene-d8 (S)	92	%.	75-125		1		04/14/17 02:10	2037-26-5	
4-Bromofluorobenzene (S)	95	%.	75-125		1		04/14/17 02:10	460-00-4	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**2470**	umhos/cm	1.0	1.0	1		04/17/17 10:39		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**5.7**	Std. Units	0.10	0.10	1		04/20/17 16:19		H6
410.4 COD	Analytical Method: EPA 410.4 Preparation Method: EPA 410.4								
Chemical Oxygen Demand	**386**	mg/L	50.0	5.4	1	04/11/17 09:12	04/11/17 12:45		
SM4500NO3-H, NO2 + NO3 pres.	Analytical Method: SM 4500-NO3 H								
Nitrogen, NO2 plus NO3	**0.29**	mg/L	0.10	0.050	1		04/14/17 09:19		
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**1190**	mg/L	100	41.6	40		04/13/17 16:26	14808-79-8	
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	**81.4**	mg/L	5.0	2.2	5		04/18/17 11:43	16887-00-6	FS
SM4500CN-E Cyanide	Analytical Method: SM 4500-CN-E Preparation Method: SM 4500-CN-E								
Cyanide	**33.2**	ug/L	10.0	4.2	1	04/17/17 11:11	04/17/17 14:23	57-12-5	

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ANALYTICAL RESULTS

Project: Old Landfill
Pace Project No.: 10384255

Sample: BSB-GW-07 **Lab ID: 10384255004** Collected: 04/06/17 10:20 Received: 04/07/17 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Acetone	**4.2J**	ug/L	20.0	2.0	1		04/14/17 02:32	67-64-1	
Acrylonitrile	ND	ug/L	10.0	0.49	1		04/14/17 02:32	107-13-1	
Benzene	**0.45J**	ug/L	1.0	0.16	1		04/14/17 02:32	71-43-2	
Bromochloromethane	ND	ug/L	1.0	0.19	1		04/14/17 02:32	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.24	1		04/14/17 02:32	75-27-4	
Bromoform	ND	ug/L	4.0	0.27	1		04/14/17 02:32	75-25-2	
Bromomethane	ND	ug/L	10.0	0.44	1		04/14/17 02:32	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		04/14/17 02:32	78-93-3	
Carbon disulfide	ND	ug/L	1.0	0.30	1		04/14/17 02:32	75-15-0	
Carbon tetrachloride	ND	ug/L	1.0	0.20	1		04/14/17 02:32	56-23-5	
Chlorobenzene	ND	ug/L	1.0	0.11	1		04/14/17 02:32	108-90-7	
Chloroethane	ND	ug/L	1.0	0.34	1		04/14/17 02:32	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		04/14/17 02:32	67-66-3	
Chloromethane	ND	ug/L	4.0	0.25	1		04/14/17 02:32	74-87-3	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		04/14/17 02:32	96-12-8	
Dibromochloromethane	ND	ug/L	1.0	0.16	1		04/14/17 02:32	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.20	1		04/14/17 02:32	106-93-4	
Dibromomethane	ND	ug/L	4.0	0.19	1		04/14/17 02:32	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	1.0	0.17	1		04/14/17 02:32	95-50-1	
1,4-Dichlorobenzene	**1.0**	ug/L	1.0	0.21	1		04/14/17 02:32	106-46-7	
trans-1,4-Dichloro-2-butene	ND	ug/L	10.0	0.45	1		04/14/17 02:32	110-57-6	
Dichlorodifluoromethane	**1.1**	ug/L	1.0	0.23	1		04/14/17 02:32	75-71-8	
1,1-Dichloroethane	**1.1**	ug/L	1.0	0.17	1		04/14/17 02:32	75-34-3	
1,2-Dichloroethane	ND	ug/L	1.0	0.17	1		04/14/17 02:32	107-06-2	
1,1-Dichloroethene	ND	ug/L	1.0	0.28	1		04/14/17 02:32	75-35-4	
cis-1,2-Dichloroethene	**1.9**	ug/L	1.0	0.12	1		04/14/17 02:32	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	1.0	0.16	1		04/14/17 02:32	156-60-5	
1,2-Dichloropropane	**0.61J**	ug/L	4.0	0.22	1		04/14/17 02:32	78-87-5	
cis-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		04/14/17 02:32	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		04/14/17 02:32	10061-02-6	
Ethylbenzene	**0.33J**	ug/L	1.0	0.15	1		04/14/17 02:32	100-41-4	
2-Hexanone	ND	ug/L	5.0	0.19	1		04/14/17 02:32	591-78-6	
Iodomethane	ND	ug/L	4.0	0.18	1		04/14/17 02:32	74-88-4	
Methylene Chloride	ND	ug/L	4.0	0.29	1		04/14/17 02:32	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.43	1		04/14/17 02:32	108-10-1	
Styrene	ND	ug/L	1.0	0.29	1		04/14/17 02:32	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	0.17	1		04/14/17 02:32	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0	0.22	1		04/14/17 02:32	79-34-5	
Tetrachloroethene	ND	ug/L	1.0	0.25	1		04/14/17 02:32	127-18-4	
Toluene	ND	ug/L	1.0	0.14	1		04/14/17 02:32	108-88-3	
1,1,1-Trichloroethane	ND	ug/L	1.0	0.17	1		04/14/17 02:32	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	1.0	0.15	1		04/14/17 02:32	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.052	1		04/14/17 02:32	79-01-6	
Trichlorofluoromethane	ND	ug/L	1.0	0.33	1		04/14/17 02:32	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.28	1		04/14/17 02:32	96-18-4	
Vinyl acetate	ND	ug/L	10.0	0.12	1		04/14/17 02:32	108-05-4	

ANALYTICAL RESULTS

Project: Old Landfill
Pace Project No.: 10384255

Sample: BSB-GW-07 **Lab ID: 10384255004** Collected: 04/06/17 10:20 Received: 04/07/17 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Vinyl chloride	**1.0**	ug/L	0.20	0.069	1		04/14/17 02:32	75-01-4	
Xylene (Total)	**ND**	ug/L	3.0	0.32	1		04/14/17 02:32	1330-20-7	
m&p-Xylene	**1.0J**	ug/L	2.0	0.11	1		04/14/17 02:32	179601-23-1	
o-Xylene	**0.71J**	ug/L	1.0	0.20	1		04/14/17 02:32	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	103	%.	75-137		1		04/14/17 02:32	17060-07-0	
Toluene-d8 (S)	92	%.	75-125		1		04/14/17 02:32	2037-26-5	
4-Bromofluorobenzene (S)	94	%.	75-125		1		04/14/17 02:32	460-00-4	

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ANALYTICAL RESULTS

Project: Old Landfill
Pace Project No.: 10384255

Sample: Trip Blank **Lab ID: 10384255005** Collected: 04/05/17 00:00 Received: 04/07/17 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Acetone	ND	ug/L	20.0	2.0	1		04/13/17 23:35	67-64-1	
Acrylonitrile	ND	ug/L	10.0	0.49	1		04/13/17 23:35	107-13-1	
Benzene	ND	ug/L	1.0	0.16	1		04/13/17 23:35	71-43-2	
Bromochloromethane	ND	ug/L	1.0	0.19	1		04/13/17 23:35	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.24	1		04/13/17 23:35	75-27-4	
Bromoform	ND	ug/L	4.0	0.27	1		04/13/17 23:35	75-25-2	
Bromomethane	ND	ug/L	10.0	0.44	1		04/13/17 23:35	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		04/13/17 23:35	78-93-3	
Carbon disulfide	ND	ug/L	1.0	0.30	1		04/13/17 23:35	75-15-0	
Carbon tetrachloride	ND	ug/L	1.0	0.20	1		04/13/17 23:35	56-23-5	
Chlorobenzene	ND	ug/L	1.0	0.11	1		04/13/17 23:35	108-90-7	
Chloroethane	ND	ug/L	1.0	0.34	1		04/13/17 23:35	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		04/13/17 23:35	67-66-3	
Chloromethane	ND	ug/L	4.0	0.25	1		04/13/17 23:35	74-87-3	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		04/13/17 23:35	96-12-8	
Dibromochloromethane	ND	ug/L	1.0	0.16	1		04/13/17 23:35	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.20	1		04/13/17 23:35	106-93-4	
Dibromomethane	ND	ug/L	4.0	0.19	1		04/13/17 23:35	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	1.0	0.17	1		04/13/17 23:35	95-50-1	
1,4-Dichlorobenzene	ND	ug/L	1.0	0.21	1		04/13/17 23:35	106-46-7	
trans-1,4-Dichloro-2-butene	ND	ug/L	10.0	0.45	1		04/13/17 23:35	110-57-6	
Dichlorodifluoromethane	ND	ug/L	1.0	0.23	1		04/13/17 23:35	75-71-8	
1,1-Dichloroethane	ND	ug/L	1.0	0.17	1		04/13/17 23:35	75-34-3	
1,2-Dichloroethane	ND	ug/L	1.0	0.17	1		04/13/17 23:35	107-06-2	
1,1-Dichloroethene	ND	ug/L	1.0	0.28	1		04/13/17 23:35	75-35-4	
cis-1,2-Dichloroethene	ND	ug/L	1.0	0.12	1		04/13/17 23:35	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	1.0	0.16	1		04/13/17 23:35	156-60-5	
1,2-Dichloropropane	ND	ug/L	4.0	0.22	1		04/13/17 23:35	78-87-5	
cis-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		04/13/17 23:35	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		04/13/17 23:35	10061-02-6	
Ethylbenzene	ND	ug/L	1.0	0.15	1		04/13/17 23:35	100-41-4	
2-Hexanone	ND	ug/L	5.0	0.19	1		04/13/17 23:35	591-78-6	
Iodomethane	ND	ug/L	4.0	0.18	1		04/13/17 23:35	74-88-4	
Methylene Chloride	ND	ug/L	4.0	0.29	1		04/13/17 23:35	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.43	1		04/13/17 23:35	108-10-1	
Styrene	ND	ug/L	1.0	0.29	1		04/13/17 23:35	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	1.0	0.17	1		04/13/17 23:35	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0	0.22	1		04/13/17 23:35	79-34-5	
Tetrachloroethene	ND	ug/L	1.0	0.25	1		04/13/17 23:35	127-18-4	
Toluene	ND	ug/L	1.0	0.14	1		04/13/17 23:35	108-88-3	
1,1,1-Trichloroethane	ND	ug/L	1.0	0.17	1		04/13/17 23:35	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	1.0	0.15	1		04/13/17 23:35	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.052	1		04/13/17 23:35	79-01-6	
Trichlorofluoromethane	ND	ug/L	1.0	0.33	1		04/13/17 23:35	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.28	1		04/13/17 23:35	96-18-4	
Vinyl acetate	ND	ug/L	10.0	0.12	1		04/13/17 23:35	108-05-4	

ANALYTICAL RESULTS

Project: Old Landfill
Pace Project No.: 10384255

Sample: Trip Blank **Lab ID: 10384255005** Collected: 04/05/17 00:00 Received: 04/07/17 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Vinyl chloride	ND	ug/L	0.20	0.069	1		04/13/17 23:35	75-01-4	
Xylene (Total)	ND	ug/L	3.0	0.32	1		04/13/17 23:35	1330-20-7	
m&p-Xylene	ND	ug/L	2.0	0.11	1		04/13/17 23:35	179601-23-1	
o-Xylene	ND	ug/L	1.0	0.20	1		04/13/17 23:35	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	101	%.	75-137		1		04/13/17 23:35	17060-07-0	
Toluene-d8 (S)	94	%.	75-125		1		04/13/17 23:35	2037-26-5	
4-Bromofluorobenzene (S)	96	%.	75-125		1		04/13/17 23:35	460-00-4	

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QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

QC Batch: 467722
QC Batch Method: EPA 200.8
Associated Lab Samples: 10384255001
Analysis Method: EPA 200.8
Analysis Description: 200.8 MET Dissolved

METHOD BLANK: 2555322
Matrix: Water
Associated Lab Samples: 10384255001

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Antimony, Dissolved	ug/L	ND	0.50	0.032	04/11/17 11:07	
Arsenic, Dissolved	ug/L	ND	0.50	0.091	04/11/17 11:07	
Barium, Dissolved	ug/L	ND	0.30	0.019	04/11/17 11:07	
Beryllium, Dissolved	ug/L	ND	0.20	0.030	04/11/17 11:07	
Cadmium, Dissolved	ug/L	ND	0.080	0.013	04/11/17 11:07	
Chromium, Dissolved	ug/L	ND	0.50	0.14	04/11/17 11:07	
Cobalt, Dissolved	ug/L	ND	0.50	0.021	04/11/17 11:07	
Copper, Dissolved	ug/L	ND	1.0	0.40	04/11/17 11:07	
Iron, Dissolved	ug/L	ND	50.0	18.5	04/11/17 11:07	
Lead, Dissolved	ug/L	0.012J	0.10	0.012	04/11/17 11:07	
Nickel, Dissolved	ug/L	ND	0.50	0.099	04/11/17 11:07	
Selenium, Dissolved	ug/L	ND	0.50	0.13	04/11/17 11:07	
Vanadium, Dissolved	ug/L	ND	1.0	0.085	04/11/17 11:07	
Zinc, Dissolved	ug/L	ND	5.0	0.78	04/11/17 11:07	

LABORATORY CONTROL SAMPLE: 2555323

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Antimony, Dissolved	ug/L	100	101	101	85-115	
Arsenic, Dissolved	ug/L	100	102	102	85-115	
Barium, Dissolved	ug/L	100	100	100	85-115	
Beryllium, Dissolved	ug/L	100	106	106	85-115	
Cadmium, Dissolved	ug/L	100	102	102	85-115	
Chromium, Dissolved	ug/L	100	105	105	85-115	
Cobalt, Dissolved	ug/L	100	98.5	98	85-115	
Copper, Dissolved	ug/L	100	97.6	98	85-115	
Iron, Dissolved	ug/L	2000	2040	102	85-115	
Lead, Dissolved	ug/L	100	99.7	100	85-115	
Nickel, Dissolved	ug/L	100	101	101	85-115	
Selenium, Dissolved	ug/L	100	104	104	85-115	
Vanadium, Dissolved	ug/L	100	102	102	85-115	
Zinc, Dissolved	ug/L	100	106	106	85-115	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2555324 2555325

Parameter	Units	10383803002 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Antimony, Dissolved	ug/L	ND	100	100	102	98.8	102	99	70-130	3	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2555324 2555325

Parameter	Units	10383803002 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic, Dissolved	ug/L	ND	100	100	102	98.9	102	99	70-130	3	20	
Barium, Dissolved	ug/L	6.8	100	100	108	105	101	99	70-130	2	20	
Beryllium, Dissolved	ug/L	ND	100	100	101	102	101	102	70-130	1	20	
Cadmium, Dissolved	ug/L	ND	100	100	103	100	103	100	70-130	2	20	
Chromium, Dissolved	ug/L	ND	100	100	102	101	102	101	70-130	1	20	
Cobalt, Dissolved	ug/L	ND	100	100	94.5	94.3	94	94	70-130	0	20	
Copper, Dissolved	ug/L	1.2	100	100	97.9	96.8	97	96	70-130	1	20	
Iron, Dissolved	ug/L	ND	2000	2000	2000	2000	100	100	70-130	0	20	
Lead, Dissolved	ug/L	ND	100	100	95.6	94.7	96	95	70-130	1	20	
Nickel, Dissolved	ug/L	0.61	100	100	99.0	97.3	98	97	70-130	2	20	
Selenium, Dissolved	ug/L	ND	100	100	101	100	101	100	70-130	1	20	
Vanadium, Dissolved	ug/L	ND	100	100	104	100	104	100	70-130	4	20	
Zinc, Dissolved	ug/L	15.2	100	100	123	119	107	103	70-130	3	20	

MATRIX SPIKE SAMPLE: 2555326

Parameter	Units	10384264004 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
Antimony, Dissolved	ug/L	ND	100	103	103	70-130	
Arsenic, Dissolved	ug/L	ND	100	102	102	70-130	
Barium, Dissolved	ug/L	0.037J	100	101	101	70-130	
Beryllium, Dissolved	ug/L	ND	100	103	103	70-130	
Cadmium, Dissolved	ug/L	ND	100	103	103	70-130	
Chromium, Dissolved	ug/L	0.26J	100	103	103	70-130	
Cobalt, Dissolved	ug/L	ND	100	96.2	96	70-130	
Copper, Dissolved	ug/L	ND	100	97.9	98	70-130	
Iron, Dissolved	ug/L	ND	2000	2030	101	70-130	
Lead, Dissolved	ug/L	ND	100	99.6	100	70-130	
Nickel, Dissolved	ug/L	ND	100	101	101	70-130	
Selenium, Dissolved	ug/L	ND	100	103	103	70-130	
Vanadium, Dissolved	ug/L	ND	100	100	100	70-130	
Zinc, Dissolved	ug/L	ND	100	106	106	70-130	

QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

QC Batch: 468508 Analysis Method: EPA 8260B
QC Batch Method: EPA 8260B Analysis Description: 8260B MSV
Associated Lab Samples: 10384255001, 10384255002, 10384255003, 10384255004, 10384255005

METHOD BLANK: 2558573 Matrix: Water
Associated Lab Samples: 10384255001, 10384255002, 10384255003, 10384255004, 10384255005

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	ND	1.0	0.17	04/13/17 22:51	
1,1,1-Trichloroethane	ug/L	ND	1.0	0.17	04/13/17 22:51	
1,1,2,2-Tetrachloroethane	ug/L	ND	1.0	0.22	04/13/17 22:51	
1,1,2-Trichloroethane	ug/L	ND	1.0	0.15	04/13/17 22:51	
1,1-Dichloroethane	ug/L	ND	1.0	0.17	04/13/17 22:51	
1,1-Dichloroethene	ug/L	ND	1.0	0.28	04/13/17 22:51	
1,2,3-Trichloropropane	ug/L	ND	4.0	0.28	04/13/17 22:51	
1,2-Dibromo-3-chloropropane	ug/L	ND	10.0	0.60	04/13/17 22:51	MN
1,2-Dibromoethane (EDB)	ug/L	ND	1.0	0.20	04/13/17 22:51	
1,2-Dichlorobenzene	ug/L	ND	1.0	0.17	04/13/17 22:51	
1,2-Dichloroethane	ug/L	ND	1.0	0.17	04/13/17 22:51	
1,2-Dichloropropane	ug/L	ND	4.0	0.22	04/13/17 22:51	
1,4-Dichlorobenzene	ug/L	ND	1.0	0.21	04/13/17 22:51	
2-Butanone (MEK)	ug/L	ND	5.0	1.1	04/13/17 22:51	
2-Hexanone	ug/L	ND	5.0	0.19	04/13/17 22:51	
4-Methyl-2-pentanone (MIBK)	ug/L	ND	5.0	0.43	04/13/17 22:51	
Acetone	ug/L	ND	20.0	2.0	04/13/17 22:51	
Acrylonitrile	ug/L	ND	10.0	0.49	04/13/17 22:51	
Benzene	ug/L	ND	1.0	0.16	04/13/17 22:51	
Bromochloromethane	ug/L	ND	1.0	0.19	04/13/17 22:51	
Bromodichloromethane	ug/L	ND	1.0	0.24	04/13/17 22:51	
Bromoform	ug/L	ND	4.0	0.27	04/13/17 22:51	
Bromomethane	ug/L	ND	10.0	0.44	04/13/17 22:51	MN
Carbon disulfide	ug/L	ND	1.0	0.30	04/13/17 22:51	
Carbon tetrachloride	ug/L	ND	1.0	0.20	04/13/17 22:51	
Chlorobenzene	ug/L	ND	1.0	0.11	04/13/17 22:51	
Chloroethane	ug/L	ND	1.0	0.34	04/13/17 22:51	
Chloroform	ug/L	ND	1.0	0.21	04/13/17 22:51	
Chloromethane	ug/L	ND	4.0	0.25	04/13/17 22:51	
cis-1,2-Dichloroethene	ug/L	ND	1.0	0.12	04/13/17 22:51	
cis-1,3-Dichloropropene	ug/L	ND	4.0	0.15	04/13/17 22:51	
Dibromochloromethane	ug/L	ND	1.0	0.16	04/13/17 22:51	
Dibromomethane	ug/L	ND	4.0	0.19	04/13/17 22:51	
Dichlorodifluoromethane	ug/L	ND	1.0	0.23	04/13/17 22:51	
Ethylbenzene	ug/L	ND	1.0	0.15	04/13/17 22:51	
Iodomethane	ug/L	ND	4.0	0.18	04/13/17 22:51	
m&p-Xylene	ug/L	ND	2.0	0.11	04/13/17 22:51	
Methylene Chloride	ug/L	ND	4.0	0.29	04/13/17 22:51	
o-Xylene	ug/L	ND	1.0	0.20	04/13/17 22:51	
Styrene	ug/L	ND	1.0	0.29	04/13/17 22:51	
Tetrachloroethene	ug/L	ND	1.0	0.25	04/13/17 22:51	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

METHOD BLANK: 2558573 Matrix: Water

Associated Lab Samples: 10384255001, 10384255002, 10384255003, 10384255004, 10384255005

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Toluene	ug/L	ND	1.0	0.14	04/13/17 22:51	
trans-1,2-Dichloroethene	ug/L	ND	1.0	0.16	04/13/17 22:51	
trans-1,3-Dichloropropene	ug/L	ND	4.0	0.15	04/13/17 22:51	
trans-1,4-Dichloro-2-butene	ug/L	ND	10.0	0.45	04/13/17 22:51	
Trichloroethene	ug/L	ND	0.40	0.052	04/13/17 22:51	
Trichlorofluoromethane	ug/L	ND	1.0	0.33	04/13/17 22:51	
Vinyl acetate	ug/L	ND	10.0	0.12	04/13/17 22:51	
Vinyl chloride	ug/L	ND	0.20	0.069	04/13/17 22:51	
Xylene (Total)	ug/L	ND	3.0	0.32	04/13/17 22:51	
1,2-Dichloroethane-d4 (S)	%.	101	75-137		04/13/17 22:51	
4-Bromofluorobenzene (S)	%.	95	75-125		04/13/17 22:51	
Toluene-d8 (S)	%.	93	75-125		04/13/17 22:51	

LABORATORY CONTROL SAMPLE & LCSD: 2558574 2558575

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	20	19.8	19.9	99	99	75-125	1	20	
1,1,1-Trichloroethane	ug/L	20	20.0	19.4	100	97	69-125	3	20	
1,1,2,2-Tetrachloroethane	ug/L	20	20.0	20.5	100	103	70-125	2	20	
1,1,2-Trichloroethane	ug/L	20	20.4	20.6	102	103	75-125	1	20	
1,1-Dichloroethane	ug/L	20	19.6	19.1	98	96	62-130	2	20	
1,1-Dichloroethene	ug/L	20	17.6	17.4	88	87	64-134	1	20	
1,2,3-Trichloropropane	ug/L	20	20.3	20.5	102	102	70-125	1	20	
1,2-Dibromo-3-chloropropane	ug/L	50	46.8	48.8	94	98	73-130	4	20	
1,2-Dibromoethane (EDB)	ug/L	20	19.2	19.6	96	98	75-125	2	20	
1,2-Dichlorobenzene	ug/L	20	20.5	20.7	103	104	75-125	1	20	
1,2-Dichloroethane	ug/L	20	19.6	19.7	98	99	64-126	0	20	
1,2-Dichloropropane	ug/L	20	20.7	20.1	104	101	73-125	3	20	
1,4-Dichlorobenzene	ug/L	20	20.3	20.1	102	101	75-125	1	20	
2-Butanone (MEK)	ug/L	100	105	103	105	103	57-142	1	20	
2-Hexanone	ug/L	100	115	115	115	115	65-127	0	20	
4-Methyl-2-pentanone (MIBK)	ug/L	100	112	112	112	112	56-142	0	20	
Acetone	ug/L	100	96.1	96.7	96	97	75-133	1	20	
Acrylonitrile	ug/L	200	199	198	99	99	59-130	0	20	
Benzene	ug/L	20	18.7	18.6	93	93	74-125	0	20	
Bromochloromethane	ug/L	20	20.7	20.6	104	103	75-125	0	20	
Bromodichloromethane	ug/L	20	19.5	19.4	98	97	72-125	1	20	
Bromoform	ug/L	20	18.8	19.1	94	96	74-125	2	20	
Bromomethane	ug/L	20	21.1	22.8	106	114	30-150	7	20	
Carbon disulfide	ug/L	20	17.3	17.1	86	86	44-133	1	20	
Carbon tetrachloride	ug/L	20	20.5	19.9	102	100	67-130	3	20	
Chlorobenzene	ug/L	20	21.5	21.1	107	106	75-125	2	20	
Chloroethane	ug/L	20	20.2	19.6	101	98	63-137	3	20	
Chloroform	ug/L	20	20.5	20.2	102	101	68-128	2	20	

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QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

LABORATORY CONTROL SAMPLE & LCSD: 2558574 2558575

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Chloromethane	ug/L	20	23.6	22.0	118	110	46-145	7	20	
cis-1,2-Dichloroethene	ug/L	20	18.6	18.6	93	93	75-125	0	20	
cis-1,3-Dichloropropene	ug/L	20	18.4	18.4	92	92	73-125	0	20	
Dibromochloromethane	ug/L	20	19.0	19.1	95	96	75-125	1	20	
Dibromomethane	ug/L	20	20.7	20.4	103	102	73-125	1	20	
Dichlorodifluoromethane	ug/L	20	21.7	21.4	109	107	36-150	2	20	
Ethylbenzene	ug/L	20	20.6	20.2	103	101	73-125	2	20	
Iodomethane	ug/L	20	17.9	17.8	89	89	30-143	0	20	
m&p-Xylene	ug/L	40	40.0	39.8	100	99	75-125	1	20	
Methylene Chloride	ug/L	20	17.9	17.1	89	85	74-125	5	20	
o-Xylene	ug/L	20	20.0	20.0	100	100	73-125	0	20	
Styrene	ug/L	20	19.2	19.0	96	95	75-128	1	20	
Tetrachloroethene	ug/L	20	19.8	19.3	99	96	71-127	3	20	
Toluene	ug/L	20	18.3	18.0	91	90	75-125	2	20	
trans-1,2-Dichloroethene	ug/L	20	17.7	17.3	88	86	69-127	2	20	
trans-1,3-Dichloropropene	ug/L	20	18.3	18.4	91	92	70-128	1	20	
trans-1,4-Dichloro-2-butene	ug/L	50	43.4	44.6	87	89	52-133	3	20	
Trichloroethene	ug/L	20	21.9	21.1	110	106	70-125	4	20	
Trichlorofluoromethane	ug/L	20	22.0	21.6	110	108	71-125	2	20	
Vinyl acetate	ug/L	20	17.6	17.5	88	87	55-134	0	20	
Vinyl chloride	ug/L	20	21.2	20.8	106	104	69-133	2	20	
Xylene (Total)	ug/L	60	60.0	59.8	100	100	75-125	0	20	
1,2-Dichloroethane-d4 (S)	%.				98	97	75-137			
4-Bromofluorobenzene (S)	%.				92	93	75-125			
Toluene-d8 (S)	%.				94	94	75-125			

MATRIX SPIKE SAMPLE: 2558576

Parameter	Units	10384699001 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	<0.17	20	20.3	101	75-138	
1,1,1-Trichloroethane	ug/L	<0.17	20	20.6	103	75-145	
1,1,2,2-Tetrachloroethane	ug/L	<0.22	20	20.2	101	73-150	
1,1,2-Trichloroethane	ug/L	<0.15	20	20.7	103	75-140	
1,1-Dichloroethane	ug/L	<0.17	20	19.9	100	75-140	
1,1-Dichloroethene	ug/L	<0.28	20	19.1	95	73-150	
1,2,3-Trichloropropane	ug/L	<0.28	20	20.5	103	75-147	
1,2-Dibromo-3-chloropropane	ug/L	<0.60	50	49.5	99	65-136	
1,2-Dibromoethane (EDB)	ug/L	<0.20	20	19.6	98	75-131	
1,2-Dichlorobenzene	ug/L	<0.17	20	21.0	105	75-141	
1,2-Dichloroethane	ug/L	<0.17	20	20.2	101	75-125	
1,2-Dichloropropane	ug/L	<0.22	20	20.8	104	71-147	
1,4-Dichlorobenzene	ug/L	<0.21	20	20.6	103	75-139	
2-Butanone (MEK)	ug/L	<1.1	100	102	102	68-133	
2-Hexanone	ug/L	<0.19	100	116	116	61-145	
4-Methyl-2-pentanone (MIBK)	ug/L	<0.43	100	112	112	67-150	

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QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

MATRIX SPIKE SAMPLE: 2558576

Parameter	Units	10384699001 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
Acetone	ug/L	<2.0	100	99.3	99	56-150	
Acrylonitrile	ug/L	<0.49	200	203	102	66-129	
Benzene	ug/L	<0.16	20	19.2	96	74-134	
Bromochloromethane	ug/L	<0.19	20	21.7	108	75-145	
Bromodichloromethane	ug/L	<0.24	20	20.0	100	75-143	
Bromoform	ug/L	<0.27	20	19.6	98	67-125	
Bromomethane	ug/L	<0.44	20	23.9	120	30-150	
Carbon disulfide	ug/L	<0.30	20	18.1	91	64-140	
Carbon tetrachloride	ug/L	<0.20	20	21.7	109	75-150	
Chlorobenzene	ug/L	<0.11	20	21.6	108	75-133	
Chloroethane	ug/L	<0.34	20	20.7	103	53-150	
Chloroform	ug/L	<0.21	20	21.2	106	75-134	
Chloromethane	ug/L	<0.25	20	23.2	116	41-150	
cis-1,2-Dichloroethene	ug/L	<0.12	20	19.0	95	73-140	
cis-1,3-Dichloropropene	ug/L	<0.15	20	18.5	92	72-140	
Dibromochloromethane	ug/L	<0.16	20	19.6	98	74-130	
Dibromomethane	ug/L	<0.19	20	20.9	104	70-141	
Dichlorodifluoromethane	ug/L	<0.23	20	25.3	126	50-150	
Ethylbenzene	ug/L	<0.15	20	20.7	104	75-136	
Iodomethane	ug/L	<0.18	20	19.1	96	57-143	
m&p-Xylene	ug/L	<0.11	40	40.4	101	75-134	
Methylene Chloride	ug/L	<0.29	20	17.2	86	69-150	
o-Xylene	ug/L	<0.20	20	20.3	101	75-129	
Styrene	ug/L	<0.29	20	19.7	98	70-140	
Tetrachloroethene	ug/L	<0.25	20	20.5	102	72-141	
Toluene	ug/L	<0.14	20	18.6	93	71-138	
trans-1,2-Dichloroethene	ug/L	<0.16	20	18.1	91	74-149	
trans-1,3-Dichloropropene	ug/L	<0.15	20	19.0	95	74-138	
trans-1,4-Dichloro-2-butene	ug/L	<0.45	50	46.0	92	42-137	
Trichloroethene	ug/L	<0.052	20	22.7	114	70-150	
Trichlorofluoromethane	ug/L	<0.33	20	24.1	121	57-150	
Vinyl acetate	ug/L	<0.12	20	17.0	85	35-149	
Vinyl chloride	ug/L	<0.069	20	22.5	113	59-150	
Xylene (Total)	ug/L	<0.32	60	60.7	101	75-131	
1,2-Dichloroethane-d4 (S)	%.				99	75-137	
4-Bromofluorobenzene (S)	%.				92	75-125	
Toluene-d8 (S)	%.				93	75-125	

SAMPLE DUPLICATE: 2558577

Parameter	Units	10384699002 Result	Dup Result	RPD	Max RPD	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	<0.17	ND		30	
1,1,1-Trichloroethane	ug/L	<0.17	ND		30	
1,1,2,2-Tetrachloroethane	ug/L	<0.22	ND		30	
1,1,2-Trichloroethane	ug/L	<0.15	ND		30	

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QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

SAMPLE DUPLICATE: 2558577

Parameter	Units	10384699002 Result	Dup Result	RPD	Max RPD	Qualifiers
1,1-Dichloroethane	ug/L	<0.17	ND		30	
1,1-Dichloroethene	ug/L	<0.28	ND		30	
1,2,3-Trichloropropane	ug/L	<0.28	ND		30	
1,2-Dibromo-3-chloropropane	ug/L	<0.60	ND		30	
1,2-Dibromoethane (EDB)	ug/L	<0.20	ND		30	
1,2-Dichlorobenzene	ug/L	<0.17	ND		30	
1,2-Dichloroethane	ug/L	<0.17	ND		30	
1,2-Dichloropropane	ug/L	<0.22	ND		30	
1,4-Dichlorobenzene	ug/L	<0.21	ND		30	
2-Butanone (MEK)	ug/L	<1.1	ND		30	
2-Hexanone	ug/L	<0.19	ND		30	
4-Methyl-2-pentanone (MIBK)	ug/L	<0.43	ND		30	
Acetone	ug/L	<2.0	ND		30	
Acrylonitrile	ug/L	<0.49	ND		30	
Benzene	ug/L	<0.16	ND		30	
Bromochloromethane	ug/L	<0.19	ND		30	
Bromodichloromethane	ug/L	<0.24	ND		30	
Bromoform	ug/L	<0.27	ND		30	
Bromomethane	ug/L	<0.44	ND		30	
Carbon disulfide	ug/L	<0.30	ND		30	
Carbon tetrachloride	ug/L	<0.20	ND		30	
Chlorobenzene	ug/L	<0.11	ND		30	
Chloroethane	ug/L	<0.34	ND		30	
Chloroform	ug/L	<0.21	ND		30	
Chloromethane	ug/L	<0.25	ND		30	
cis-1,2-Dichloroethene	ug/L	<0.12	ND		30	
cis-1,3-Dichloropropene	ug/L	<0.15	ND		30	
Dibromochloromethane	ug/L	<0.16	ND		30	
Dibromomethane	ug/L	<0.19	ND		30	
Dichlorodifluoromethane	ug/L	<0.23	ND		30	
Ethylbenzene	ug/L	<0.15	ND		30	
Iodomethane	ug/L	<0.18	ND		30	
m&p-Xylene	ug/L	<0.11	ND		30	
Methylene Chloride	ug/L	<0.29	ND		30	
o-Xylene	ug/L	<0.20	ND		30	
Styrene	ug/L	<0.29	ND		30	
Tetrachloroethene	ug/L	<0.25	ND		30	
Toluene	ug/L	<0.14	ND		30	
trans-1,2-Dichloroethene	ug/L	<0.16	ND		30	
trans-1,3-Dichloropropene	ug/L	<0.15	ND		30	
trans-1,4-Dichloro-2-butene	ug/L	<0.45	ND		30	
Trichloroethene	ug/L	<0.052	ND		30	
Trichlorofluoromethane	ug/L	<0.33	ND		30	
Vinyl acetate	ug/L	<0.12	ND		30	
Vinyl chloride	ug/L	<0.069	ND		30	
Xylene (Total)	ug/L	<0.32	ND		30	
1,2-Dichloroethane-d4 (S)	%.	103	102	1		

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QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

SAMPLE DUPLICATE: 2558577

Parameter	Units	10384699002 Result	Dup Result	RPD	Max RPD	Qualifiers
4-Bromofluorobenzene (S)	%.	93	95	2		
Toluene-d8 (S)	%.	92	92	0		

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QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

QC Batch: 468860
QC Batch Method: EPA 120.1
Analysis Method: EPA 120.1
Analysis Description: 120.1 Specific Conductance
Associated Lab Samples: 10384255001, 10384255002, 10384255003

METHOD BLANK: 2560835
Matrix: Water
Associated Lab Samples: 10384255001, 10384255002, 10384255003

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Specific Conductance	umhos/cm	ND	1.0	1.0	04/17/17 10:05	

LABORATORY CONTROL SAMPLE: 2560836

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Specific Conductance	umhos/cm	1000	943	94	90-110	

SAMPLE DUPLICATE: 2560837

Parameter	Units	10383965009 Result	Dup Result	RPD	Max RPD	Qualifiers
Specific Conductance	umhos/cm	340	335	1	20	

SAMPLE DUPLICATE: 2560838

Parameter	Units	10383927001 Result	Dup Result	RPD	Max RPD	Qualifiers
Specific Conductance	umhos/cm	1840	1820	1	20	

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QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

QC Batch: 469460
QC Batch Method: SM 4500-H+B
Analysis Method: SM 4500-H+B
Analysis Description: 4500H+B pH
Associated Lab Samples: 10384255001, 10384255002, 10384255003

LABORATORY CONTROL SAMPLE: 2563418

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
pH at 25 Degrees C	Std. Units	5	5.1	101	98-102	H6

SAMPLE DUPLICATE: 2563419

Parameter	Units	10384255002 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	7.0	7.0	0	3	H6

SAMPLE DUPLICATE: 2563420

Parameter	Units	10383931001 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	7.5	7.4	1	3	H6

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QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

QC Batch: 467940
Analysis Method: EPA 410.4
QC Batch Method: EPA 410.4
Analysis Description: 410.4 COD
Associated Lab Samples: 10384255001, 10384255002, 10384255003

METHOD BLANK: 2556031
Matrix: Water
Associated Lab Samples: 10384255001, 10384255002, 10384255003

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Chemical Oxygen Demand	mg/L	ND	50.0	5.4	04/11/17 12:43	

LABORATORY CONTROL SAMPLE: 2556032

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Chemical Oxygen Demand	mg/L	300	300	100	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2556033 2556034

Parameter	Units	10384112001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chemical Oxygen Demand	mg/L	79.9	250	250	337	328	103	99	90-110	3	20	

QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

QC Batch: 468578 Analysis Method: SM 4500-NO3 H
QC Batch Method: SM 4500-NO3 H Analysis Description: SM4500NO3-H, NO2 + NO3 pres.
Associated Lab Samples: 10384255001, 10384255002, 10384255003

METHOD BLANK: 2559163 Matrix: Water
Associated Lab Samples: 10384255001, 10384255002, 10384255003

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Nitrogen, NO2 plus NO3	mg/L	ND	0.10	0.050	04/14/17 09:04	

LABORATORY CONTROL SAMPLE: 2559164

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Nitrogen, NO2 plus NO3	mg/L	2.5	2.5	99	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2559165 2559166

Parameter	Units	10384646001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, NO2 plus NO3	mg/L	ND	2.5	2.5	0.38	0.36	15	14	80-120	4	30	M1

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2559167 2559168

Parameter	Units	10384646002 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, NO2 plus NO3	mg/L	ND	2.5	2.5	0.28	0.32	11	13	80-120	12	30	M1

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QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

QC Batch: 468337
Analysis Method: ASTM D516
QC Batch Method: ASTM D516
Analysis Description: ASTM D516 Sulfate Water
Associated Lab Samples: 10384255001, 10384255002, 10384255003

METHOD BLANK: 2557790
Matrix: Water
Associated Lab Samples: 10384255001, 10384255002, 10384255003

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Sulfate	mg/L	ND	2.5	1.0	04/13/17 15:09	

LABORATORY CONTROL SAMPLE & LCSD: 2557791 2557792

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Sulfate	mg/L	7.5	8.3	8.1	111	109	80-120	2	20	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2557793 2557794

Parameter	Units	10383897001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Sulfate	mg/L	ND	20	20	21.1	21.5	103	105	80-120	2	30	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2557795 2557796

Parameter	Units	10384466004 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Sulfate	mg/L	71.8	20	20	88.8	87.1	85	76	80-120	2	30	M1

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

QC Batch: 468013
Analysis Method: SM 4500-Cl E
QC Batch Method: SM 4500-Cl E
Analysis Description: SM4500Cl-E Chloride
Associated Lab Samples: 10384255001, 10384255002

METHOD BLANK: 2556258
Matrix: Water
Associated Lab Samples: 10384255001, 10384255002

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Chloride	mg/L	ND	1.0	0.45	04/11/17 17:04	FS

LABORATORY CONTROL SAMPLE: 2556259

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Chloride	mg/L	15	15.3	102	90-110	FS

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2556260 2556261

Parameter	Units	10383767003 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	24.1	15	15	35.1	35.5	73	77	80-120	1	30	M1

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2556262 2556263

Parameter	Units	10384255002 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	19.6	15	15	31.3	31.0	78	76	80-120	1	30	M1

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

QC Batch: 469071
Analysis Method: SM 4500-Cl E
QC Batch Method: SM 4500-Cl E
Analysis Description: SM4500Cl-E Chloride
Associated Lab Samples: 10384255003

METHOD BLANK: 2561557
Matrix: Water
Associated Lab Samples: 10384255003

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Chloride	mg/L	ND	1.0	0.45	04/18/17 11:11	FS

LABORATORY CONTROL SAMPLE: 2561558

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Chloride	mg/L	15	15.0	100	90-110	FS

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2561559 2561560

Parameter	Units	10384255003 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	81.4	15	15	94.4	95.1	87	92	80-120	1	30	FS

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2561561 2561562

Parameter	Units	10384466004 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	28.7	15	15	43.0	42.3	96	91	80-120	2	30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

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QUALITY CONTROL DATA

Project: Old Landfill
Pace Project No.: 10384255

QC Batch: 468824
Analysis Method: SM 4500-CN-E
QC Batch Method: SM 4500-CN-E
Analysis Description: SM4500CN-E Cyanide
Associated Lab Samples: 10384255001, 10384255002, 10384255003

METHOD BLANK: 2560698
Matrix: Water
Associated Lab Samples: 10384255001, 10384255002, 10384255003

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Cyanide	ug/L	ND	10.0	4.2	04/17/17 13:54	

LABORATORY CONTROL SAMPLE: 2560699

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Cyanide	ug/L	250	257	103	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2560700 2560701

Parameter	Units	1285314001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Cyanide	ug/L	<10.0	250	250	250	273	99	108	80-120	9	30	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2560702 2560703

Parameter	Units	1285173001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Cyanide	ug/L	ND	250	250	261	260	104	103	80-120	0	30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALIFIERS

Project: Old Landfill
Pace Project No.: 10384255

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.
ND - Not Detected at or above adjusted reporting limit.
J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
MDL - Adjusted Method Detection Limit.
PQL - Practical Quantitation Limit.
RL - Reporting Limit.
S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)
MS(D) - Matrix Spike (Duplicate)
DUP - Sample Duplicate
RPD - Relative Percent Difference
NC - Not Calculable.
SG - Silica Gel - Clean-Up
U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-M	Pace Analytical Services - Minneapolis

BATCH QUALIFIERS

Batch: 468508

[M5]	A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

ANALYTE QUALIFIERS

B	Analyte was detected in the associated method blank.
FS	The sample was filtered in the laboratory prior to analysis.
H6	Analysis initiated outside of the 15 minute EPA required holding time.
M1	Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.
MN	The reporting limit has been raised in accordance with Minnesota Statutes 4740.2100 Subpart 8. C, D. Reporting Limit Evaluation Rule.

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: Old Landfill
Pace Project No.: 10384255

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
10384255001	BSB-GW-01	EPA 200.8	467722	EPA 200.8	467841
10384255001	BSB-GW-01	EPA 8260B	468508		
10384255002	BSB-GW-02	EPA 8260B	468508		
10384255003	BSB-GW-04	EPA 8260B	468508		
10384255004	BSB-GW-07	EPA 8260B	468508		
10384255005	Trip Blank	EPA 8260B	468508		
10384255001	BSB-GW-01	EPA 120.1	468860		
10384255002	BSB-GW-02	EPA 120.1	468860		
10384255003	BSB-GW-04	EPA 120.1	468860		
10384255001	BSB-GW-01	SM 4500-H+B	469460		
10384255002	BSB-GW-02	SM 4500-H+B	469460		
10384255003	BSB-GW-04	SM 4500-H+B	469460		
10384255001	BSB-GW-01	EPA 410.4	467940	EPA 410.4	468031
10384255002	BSB-GW-02	EPA 410.4	467940	EPA 410.4	468031
10384255003	BSB-GW-04	EPA 410.4	467940	EPA 410.4	468031
10384255001	BSB-GW-01	SM 4500-NO3 H	468578		
10384255002	BSB-GW-02	SM 4500-NO3 H	468578		
10384255003	BSB-GW-04	SM 4500-NO3 H	468578		
10384255001	BSB-GW-01	ASTM D516	468337		
10384255002	BSB-GW-02	ASTM D516	468337		
10384255003	BSB-GW-04	ASTM D516	468337		
10384255001	BSB-GW-01	SM 4500-Cl E	468013		
10384255002	BSB-GW-02	SM 4500-Cl E	468013		
10384255003	BSB-GW-04	SM 4500-Cl E	469071		
10384255001	BSB-GW-01	SM 4500-CN-E	468824	SM 4500-CN-E	468946
10384255002	BSB-GW-02	SM 4500-CN-E	468824	SM 4500-CN-E	468946
10384255003	BSB-GW-04	SM 4500-CN-E	468824	SM 4500-CN-E	468946

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CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

10384255

Page: 1 of 1

Section A
Required Client Information:

Company: Pioneer Technical
Address: 1101 South Montana St
Butte MT 59701
Email To: varmstrong@pioneer-technical.com
Phone: ~~406-563-9374~~ 406-497-8054
Fax:
Requested Due Date/TAT: standard

Section B
Required Project Information:

Report To: ~~Brad Holloman~~ Vanessa Armstrong
Copy To:
Purchase Order No.:
Project Name: Old Landfill
Project Number:

Section C
Invoice Information:

Attention: Dave Schultz (406-497-6515)
Company Name: BSB Public Works Dept
Address: 126 W. Granite Butte,MT 59701
Pace Quote Reference:
Pace Project Manager: Bob Michels
Pace Profile #: 22208

REGULATORY AGENCY

☐ NPDES ☒ GROUND WATER ☐ DRINKING WATER
☐ UST ☐ RCRA ☐ OTHER MDEQ

Site Location STATE: MT

Section D
Required Client Information

SAMPLE ID
(A-Z, 0-9 / ,-)
Sample IDs MUST BE UNIQUE

Valid Matrix Codes MATRIX	CODE
DRINKING WATER	DW
WATER	WT
WASTE WATER	WW
PRODUCT	P
SOIL/SOLID	SL
OIL	OL
WIPE	WP
AIR	AR
OTHER	OT
TISSUE	TS

ITEM #	SAMPLE ID	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED COMPOSITE START DATE	COMPOSITE START TIME	COMPOSITE END/GRAB DATE	COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Preservatives Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	↓Analysis Test↓ Y/N	Cyanide	NO2+NO3 and COD	VOC's by 8260	pH, SC, Cl, SO4	Dissolved Metals *	Sulfide							Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
	Requested Analysis Filtered (Y/N)																						Y									
1	BSB-GW-01	WT		4/5/17	1030				7	1	1	1	3	1					X	X	X	X	X									001
2	BSB-GW-02	WT		4/5/17	1237				6	1	1		3	1					X	X	X	X										002
3	BSB-GW-04	WT		4/6/17	0945				6	1	1		3	1					X	X	X	X										003
4	BSB-GW-07	WT		4/6/17	1020				3				3								X											004
5	trip Blank	WT							3												X											005
6		WT																														
7		WT																														
8		WT																														
9		WT																														
10																																
11																																
12																																

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)
* 200.8 - Sb, As, Ba, Be, Cd, Cr Co, Cu, Fe, Pb, Ni, Se, V, Zn	Vanessa Armstrong / Pioneer	4/6/17	1510	Chevelle / PACE	4/7/17	9:45	2.1	Y	Y	Y

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER: Vanessa Armstrong
SIGNATURE of SAMPLER:
DATE Signed (MM/DD/YY): 4/6/17

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.

F-ALL-Q-020rev.07, 15-Feb-2007

Pace Analytical®	Document Name: **Sample Condition Upon Receipt Form**	Document Revised: 19Dec2016 Page 1 of 2
	Document No.: **F-MN-L-213-rev.20**	Issuing Authority: Pace Minnesota Quality Office

Sample Condition Upon Receipt

Client Name: Pioneer Technical

Project #:

WO# : 10384255

10384255

Courier: ☒Fed Ex ☐UPS ☐USPS ☐Client

☐Commercial ☐Pace ☐SpeeDee ☐Other:

Tracking Number: 7016 3372 6060

Custody Seal on Cooler/Box Present? ☒Yes ☐No **Seals Intact?** ☒Yes ☐No

Optional: Proj. Due Date: Proj. Name:

Packing Material: ☐Bubble Wrap ☒Bubble Bags ☐None ☐Other:

Temp Blank? ☒Yes ☐No

Thermometer Used: ☒151401163 ☐151401164

Type of Ice: ☒Wet ☐Blue ☐None ☐Samples on ice, cooling process has begun

Cooler Temp Read (°C): 1.9 **Cooler Temp Corrected (°C):** 2.1 **Biological Tissue Frozen?** ☐Yes ☐No ☒N/A

Temp should be above freezing to 6°C **Correction Factor:** +0.2 **Date and Initials of Person Examining Contents:** CSG 4/7/17

USDA Regulated Soil (☒N/A, water sample)

Did samples originate in a quarantine zone within the United States: AL, AR, CA, FL, GA, ID, LA. MS, NC, NM, NY, OK, OR, SC, TN, TX or VA (check maps)? ☐Yes ☐No

Did samples originate from a foreign source (internationally, including Hawaii and Puerto Rico)? ☐Yes ☐No

If Yes to either question, fill out a Regulated Soil Checklist (F-MN-Q-338) and include with SCUR/COC paperwork.

				COMMENTS:
Chain of Custody Present?	☒Yes	☐No		1.
Chain of Custody Filled Out?	☒Yes	☐No		2.
Chain of Custody Relinquished?	☒Yes	☐No		3.
Sampler Name and/or Signature on COC?	☒Yes	☐No	☐N/A	4.
Samples Arrived within Hold Time?	☒Yes	☐No		5.
Short Hold Time Analysis (<72 hr)?	☐Yes	☒No		6.
Rush Turn Around Time Requested?	☐Yes	☒No		7.
Sufficient Volume?	☒Yes	☐No		8.
Correct Containers Used?	☒Yes	☐No		9.
-Pace Containers Used?	☒Yes	☐No		
Containers Intact?	☒Yes	☐No		10.
Filtered Volume Received for Dissolved Tests?	☒Yes	☐No	☐N/A	11. Note if sediment is visible in the dissolved container
Sample Labels Match COC? -Includes Date/Time/ID/Analysis Matrix: WT	☐Yes	☒No		12. "GW-04" on labels: 10:10 on COC: 9:45
All containers needing acid/base preservation have been checked?	☒Yes	☐No	☐N/A	13. ☒HNO₃ ☒H₂SO₄ ☒NaOH Positive for Res. Chlorine? Y [✓ N]
All containers needing preservation are found to be in compliance with EPA recommendation? (HNO_3, H_2SO_4 <2pH, NaOH >9 Sulfide, NaOH>12 Cyanide)	☒Yes	☐No	☐N/A	Sample # 1-3 ✓ ✓ ✓
Exceptions: [✓ VOA]/Coliform, TOC/DOC Oil and Grease, DRO/8015 (water) and Dioxin.	☒Yes	☐No	☐N/A	Initial when completed: ______ Lot # of added preservative: ______
Headspace in VOA Vials (>6mm)?	☐Yes	☒No	☐N/A	14.
Trip Blank Present?	☒Yes	☐No	☐N/A	15.
Trip Blank Custody Seals Present?	☒Yes	☐No	☐N/A	
Pace Trip Blank Lot # (if purchased): n4592				

CLIENT NOTIFICATION/RESOLUTION

Field Data Required? ☐Yes ☐No

Person Contacted: Date/Time:

Comments/Resolution:

Project Manager Review: BL VL **Date:** 4/7/17

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers).

Pace Analytical®
www.pacelabs.com

Pace Analytical Services, LLC
1700 Elm Street - Suite 200
Minneapolis, MN 55414
(612)607-1700

April 21, 2017

Vanessa Armstrong
Pioneer Technical Services
1101 S. Montana Street
Butte, MT 59701

RE: Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

Dear Vanessa Armstrong:
Enclosed are the analytical results for sample(s) received by the laboratory on April 07, 2017. The results relate only to the samples included in this report. Results reported herein conform to the most current, applicable TNI/NELAC standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Bob Michels
bob.michels@pacelabs.com
(612)607-6452
Project Manager

Enclosures

cc: Julie Flammang, Pioneer Technical
Brad Hollamon, Pioneer Technical Services

CERTIFICATIONS

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

Minnesota Certification IDs

1700 Elm Street SE, Suite 200, Minneapolis, MN 55414
A2LA Certification #: 2926.01
Alabama Certification #: 40770
Alaska Contaminated Sites Certification #: UST-078
Alaska DW Certification #: MN00064
Arizona Certification #: AZ0014
Arkansas Certification #: 88-0680
California Certification #: MN00064
CNMI Saipan Certification #:MP0003
Colorado Certification #: MN00064
Connecticut Certification #: PH-0256
EPA Region 8 Certification #: 8TMS-L
Florida Certification #: E87605
Georgia Certification #: 959
Guam EPA Certification #: MN00064
Hawaii Certification #: MN00064
Idaho Certification #: MN00064
Illinois Certification #: 200011
Indiana Certification #: C-MN-01
Iowa Certification #: 368
Kansas Certification #: E-10167
Kentucky DW Certification #: 90062
Kentucky WW Certification #: 90062
Louisiana DEQ Certification #: 03086
Louisiana DW Certification #: MN00064
Maine Certification #: MN00064
Maryland Certification #: 322
Michigan Certification #: 9909
Minnesota Certification #: 027-053-137
Mississippi Certification #: MN00064
Montana Certification #: CERT0092
Nebraska Certification #: NE-OS-18-06
Nevada Certification #: MN00064
New Hampshire Certification #: 2081
New Jersey Certification #: MN002
New York Certification #: 11647
North Carolina DW Certification #: 27700
North Carolina WW Certification #: 530
North Dakota Certification #: R-036
Ohio DW Certification #: 41244
Ohio VAP Certification #: CL101
Oklahoma Certification #: 9507
Oregon NwTPH Certification #: MN300001
Oregon Secondary Certification #: MN200001
Pennsylvania Certification #: 68-00563
Puerto Rico Certification #: MN00064
South Carolina Certification #:74003001
Tennessee Certification #: TN02818
Texas Certification #: T104704192
Utah Certification #: MN00064
Virginia Certification #: 460163
Washington Certification #: C486
West Virginia DW Certification #: 9952 C
West Virginia WW Certification #: 382
Wisconsin Certification #: 999407970
Wyoming via EPA Region 8 Certification #: 8TMS-L

SAMPLE SUMMARY

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

Lab ID	Sample ID	Matrix	Date Collected	Date Received
10384264001	**BSB-GW-06**	Water	04/06/17 11:37	04/07/17 09:45
10384264002	**BSB-GW-05**	Water	04/06/17 12:50	04/07/17 09:45
10384264003	**BSB-GW-08**	Water	04/06/17 12:57	04/07/17 09:45
10384264004	**BSB-GW-09**	Water	04/06/17 14:10	04/07/17 09:45

SAMPLE ANALYTE COUNT

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
10384264001	**BSB-GW-06**	EPA 200.8	TT3	14	PASI-M
		EPA 120.1	AJS	1	PASI-M
		SM 4500-H+B	AR3	1	PASI-M
		ASTM D516	JFP	1	PASI-M
		SM 4500-Cl E	JFP	1	PASI-M
10384264002	**BSB-GW-05**	EPA 200.8	TT3	14	PASI-M
		EPA 120.1	AJS	1	PASI-M
		SM 4500-H+B	AR3	1	PASI-M
		ASTM D516	JFP	1	PASI-M
		SM 4500-Cl E	JFP	1	PASI-M
10384264003	**BSB-GW-08**	EPA 200.8	TT3	14	PASI-M
		EPA 120.1	AJS	1	PASI-M
		SM 4500-H+B	AR3	1	PASI-M
		ASTM D516	JFP	1	PASI-M
		SM 4500-Cl E	JFP	1	PASI-M
10384264004	**BSB-GW-09**	EPA 200.8	TT3	14	PASI-M
		EPA 120.1	AJS	1	PASI-M
		SM 4500-H+B	AR3	1	PASI-M
		ASTM D516	JFP	1	PASI-M
		SM 4500-Cl E	JFP	1	PASI-M

PROJECT NARRATIVE

Project:	Old Landfill/Clark Tellings
Pace Project No.:	10384264

Method: **EPA 200.8**
Description: 200.8 MET ICPMS, Dissolved
Client: Pioneer Technical
Date: April 21, 2017

General Information:
4 samples were analyzed for EPA 200.8. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 200.8 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Internal Standards:
All internal standards were within QC limits with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

QC Batch: 467722

B: Analyte was detected in the associated method blank.
- BLANK for HBN 467722 [MPRP/712 (Lab ID: 2555322)
  - Lead, Dissolved

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

Method: **EPA 120.1**
Description: 120.1 Specific Conductance
Client: Pioneer Technical
Date: April 21, 2017

General Information:
4 samples were analyzed for EPA 120.1. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project:	Old Landfill/Clark Tellings
Pace Project No.:	10384264

Method: **SM 4500-H+B**
Description: 4500H+ pH, Electrometric
Client: Pioneer Technical
Date: April 21, 2017

General Information:
4 samples were analyzed for SM 4500-H+B. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

H6: Analysis initiated outside of the 15 minute EPA required holding time.
- BSB-GW-05 (Lab ID: 10384264002)
- BSB-GW-06 (Lab ID: 10384264001)
- BSB-GW-08 (Lab ID: 10384264003)
- BSB-GW-09 (Lab ID: 10384264004)

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

Method: **ASTM D516**
Description: ASTM D516 Sulfate Water
Client: Pioneer Technical
Date: April 21, 2017

General Information:
4 samples were analyzed for ASTM D516. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 468337

A matrix spike and/or matrix spike duplicate (MS/MSD) were performed on the following sample(s): 10383897001,10384466004

M1: Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.

- MSD (Lab ID: 2557796)
  - Sulfate

Additional Comments:

PROJECT NARRATIVE

Project:	Old Landfill/Clark Tellings
Pace Project No.:	10384264

Method: **SM 4500-Cl E**
Description: SM4500Cl-E Chloride
Client: Pioneer Technical
Date: April 21, 2017

General Information:
4 samples were analyzed for SM 4500-Cl E. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

This data package has been reviewed for quality and completeness and is approved for release.

ANALYTICAL RESULTS

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

Sample: BSB-GW-06 **Lab ID: 10384264001** Collected: 04/06/17 11:37 Received: 04/07/17 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Antimony, Dissolved	**0.17J**	ug/L	0.50	0.032	1	04/10/17 10:43	04/11/17 11:51	7440-36-0	
Arsenic, Dissolved	**1.3**	ug/L	0.50	0.091	1	04/10/17 10:43	04/11/17 11:51	7440-38-2	
Barium, Dissolved	**17.1**	ug/L	0.30	0.019	1	04/10/17 10:43	04/11/17 11:51	7440-39-3	
Beryllium, Dissolved	ND	ug/L	0.20	0.030	1	04/10/17 10:43	04/11/17 11:51	7440-41-7	
Cadmium, Dissolved	**1.4**	ug/L	0.080	0.013	1	04/10/17 10:43	04/11/17 11:51	7440-43-9	
Chromium, Dissolved	**0.22J**	ug/L	0.50	0.14	1	04/10/17 10:43	04/11/17 11:51	7440-47-3	
Cobalt, Dissolved	**0.52**	ug/L	0.50	0.021	1	04/10/17 10:43	04/11/17 11:51	7440-48-4	
Copper, Dissolved	**2.3**	ug/L	1.0	0.40	1	04/10/17 10:43	04/11/17 11:51	7440-50-8	
Iron, Dissolved	**25.1J**	ug/L	50.0	18.5	1	04/10/17 10:43	04/11/17 11:51	7439-89-6	
Lead, Dissolved	**0.017J**	ug/L	0.10	0.012	1	04/10/17 10:43	04/11/17 11:51	7439-92-1	B
Nickel, Dissolved	**54.3**	ug/L	0.50	0.099	1	04/10/17 10:43	04/11/17 11:51	7440-02-0	
Selenium, Dissolved	ND	ug/L	0.50	0.13	1	04/10/17 10:43	04/11/17 11:51	7782-49-2	
Vanadium, Dissolved	**2.1**	ug/L	1.0	0.085	1	04/10/17 10:43	04/11/17 11:51	7440-62-2	
Zinc, Dissolved	**916**	ug/L	50.0	7.8	10	04/10/17 10:43	04/11/17 12:04	7440-66-6	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**1680**	umhos/cm	1.0	1.0	1		04/17/17 10:41		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**6.2**	Std. Units	0.10	0.10	1		04/20/17 16:22		H6
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**710**	mg/L	75.0	31.2	30		04/13/17 16:13	14808-79-8	
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	**66.6**	mg/L	5.0	2.2	5		04/18/17 11:43	16887-00-6	

ANALYTICAL RESULTS

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

Sample: BSB-GW-05 **Lab ID: 10384264002** Collected: 04/06/17 12:50 Received: 04/07/17 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Antimony, Dissolved	**0.17J**	ug/L	0.50	0.032	1	04/10/17 10:43	04/11/17 11:53	7440-36-0	
Arsenic, Dissolved	**55.6**	ug/L	0.50	0.091	1	04/10/17 10:43	04/11/17 11:53	7440-38-2	
Barium, Dissolved	**20.9**	ug/L	0.30	0.019	1	04/10/17 10:43	04/11/17 11:53	7440-39-3	
Beryllium, Dissolved	**0.39**	ug/L	0.20	0.030	1	04/10/17 10:43	04/11/17 11:53	7440-41-7	
Cadmium, Dissolved	**12.6**	ug/L	0.080	0.013	1	04/10/17 10:43	04/11/17 11:53	7440-43-9	
Chromium, Dissolved	**0.16J**	ug/L	0.50	0.14	1	04/10/17 10:43	04/11/17 11:53	7440-47-3	
Cobalt, Dissolved	**29.9**	ug/L	0.50	0.021	1	04/10/17 10:43	04/11/17 11:53	7440-48-4	
Copper, Dissolved	**0.90J**	ug/L	1.0	0.40	1	04/10/17 10:43	04/11/17 11:53	7440-50-8	
Iron, Dissolved	**7730**	ug/L	50.0	18.5	1	04/10/17 10:43	04/11/17 11:53	7439-89-6	
Lead, Dissolved	**0.016J**	ug/L	0.10	0.012	1	04/10/17 10:43	04/11/17 11:53	7439-92-1	B
Nickel, Dissolved	**33.1**	ug/L	0.50	0.099	1	04/10/17 10:43	04/11/17 11:53	7440-02-0	
Selenium, Dissolved	ND	ug/L	0.50	0.13	1	04/10/17 10:43	04/11/17 11:53	7782-49-2	
Vanadium, Dissolved	**0.35J**	ug/L	1.0	0.085	1	04/10/17 10:43	04/11/17 11:53	7440-62-2	
Zinc, Dissolved	**45600**	ug/L	1000	156	200	04/10/17 10:43	04/11/17 12:26	7440-66-6	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**1480**	umhos/cm	1.0	1.0	1		04/17/17 10:42		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**5.9**	Std. Units	0.10	0.10	1		04/20/17 16:21		H6
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**669**	mg/L	75.0	31.2	30		04/13/17 16:13	14808-79-8	
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	**29.6**	mg/L	2.0	0.90	2		04/18/17 11:33	16887-00-6	FS

ANALYTICAL RESULTS

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

Sample: BSB-GW-08 **Lab ID: 10384264003** Collected: 04/06/17 12:57 Received: 04/07/17 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Antimony, Dissolved	**0.27J**	ug/L	0.50	0.032	1	04/10/17 10:43	04/11/17 11:56	7440-36-0	
Arsenic, Dissolved	**56.4**	ug/L	0.50	0.091	1	04/10/17 10:43	04/11/17 11:56	7440-38-2	
Barium, Dissolved	**20.4**	ug/L	0.30	0.019	1	04/10/17 10:43	04/11/17 11:56	7440-39-3	
Beryllium, Dissolved	**0.39**	ug/L	0.20	0.030	1	04/10/17 10:43	04/11/17 11:56	7440-41-7	
Cadmium, Dissolved	**12.2**	ug/L	0.080	0.013	1	04/10/17 10:43	04/11/17 11:56	7440-43-9	
Chromium, Dissolved	ND	ug/L	0.50	0.14	1	04/10/17 10:43	04/11/17 11:56	7440-47-3	
Cobalt, Dissolved	**29.6**	ug/L	0.50	0.021	1	04/10/17 10:43	04/11/17 11:56	7440-48-4	
Copper, Dissolved	**1.0J**	ug/L	1.0	0.40	1	04/10/17 10:43	04/11/17 11:56	7440-50-8	
Iron, Dissolved	**7630**	ug/L	50.0	18.5	1	04/10/17 10:43	04/11/17 11:56	7439-89-6	
Lead, Dissolved	**0.030J**	ug/L	0.10	0.012	1	04/10/17 10:43	04/11/17 11:56	7439-92-1	B
Nickel, Dissolved	**32.4**	ug/L	0.50	0.099	1	04/10/17 10:43	04/11/17 11:56	7440-02-0	
Selenium, Dissolved	ND	ug/L	0.50	0.13	1	04/10/17 10:43	04/11/17 11:56	7782-49-2	
Vanadium, Dissolved	**0.30J**	ug/L	1.0	0.085	1	04/10/17 10:43	04/11/17 11:56	7440-62-2	
Zinc, Dissolved	**44000**	ug/L	1000	156	200	04/10/17 10:43	04/11/17 12:29	7440-66-6	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**1480**	umhos/cm	1.0	1.0	1		04/17/17 10:43		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**6.1**	Std. Units	0.10	0.10	1		04/20/17 16:23		H6
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**692**	mg/L	75.0	31.2	30		04/13/17 16:13	14808-79-8	
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	**30.4**	mg/L	2.0	0.90	2		04/18/17 11:33	16887-00-6	FS

ANALYTICAL RESULTS

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

Sample: BSB-GW-09 **Lab ID: 10384264004** Collected: 04/06/17 14:10 Received: 04/07/17 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Antimony, Dissolved	ND	ug/L	0.50	0.032	1	04/10/17 10:43	04/11/17 12:14	7440-36-0	
Arsenic, Dissolved	ND	ug/L	0.50	0.091	1	04/10/17 10:43	04/11/17 12:14	7440-38-2	
Barium, Dissolved	**0.037J**	ug/L	0.30	0.019	1	04/10/17 10:43	04/11/17 12:14	7440-39-3	
Beryllium, Dissolved	ND	ug/L	0.20	0.030	1	04/10/17 10:43	04/11/17 12:14	7440-41-7	
Cadmium, Dissolved	ND	ug/L	0.080	0.013	1	04/10/17 10:43	04/11/17 12:14	7440-43-9	
Chromium, Dissolved	**0.26J**	ug/L	0.50	0.14	1	04/10/17 10:43	04/11/17 12:14	7440-47-3	
Cobalt, Dissolved	ND	ug/L	0.50	0.021	1	04/10/17 10:43	04/11/17 12:14	7440-48-4	
Copper, Dissolved	ND	ug/L	1.0	0.40	1	04/10/17 10:43	04/11/17 12:14	7440-50-8	
Iron, Dissolved	ND	ug/L	50.0	18.5	1	04/10/17 10:43	04/11/17 12:14	7439-89-6	
Lead, Dissolved	ND	ug/L	0.10	0.012	1	04/10/17 10:43	04/11/17 12:14	7439-92-1	
Nickel, Dissolved	ND	ug/L	0.50	0.099	1	04/10/17 10:43	04/11/17 12:14	7440-02-0	
Selenium, Dissolved	ND	ug/L	0.50	0.13	1	04/10/17 10:43	04/11/17 12:14	7782-49-2	
Vanadium, Dissolved	ND	ug/L	1.0	0.085	1	04/10/17 10:43	04/11/17 12:14	7440-62-2	
Zinc, Dissolved	ND	ug/L	5.0	0.78	1	04/10/17 10:43	04/11/17 12:14	7440-66-6	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**2.8**	umhos/cm	1.0	1.0	1		04/18/17 11:29		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**5.1**	Std. Units	0.10	0.10	1		04/20/17 16:44		H6
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	ND	mg/L	2.5	1.0	1		04/13/17 15:22	14808-79-8	
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	ND	mg/L	1.0	0.45	1		04/18/17 11:14	16887-00-6	

QUALITY CONTROL DATA

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

QC Batch: 467722 Analysis Method: EPA 200.8
QC Batch Method: EPA 200.8 Analysis Description: 200.8 MET Dissolved
Associated Lab Samples: 10384264001, 10384264002, 10384264003, 10384264004

METHOD BLANK: 2555322 Matrix: Water
Associated Lab Samples: 10384264001, 10384264002, 10384264003, 10384264004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Antimony, Dissolved	ug/L	ND	0.50	0.032	04/11/17 11:07	
Arsenic, Dissolved	ug/L	ND	0.50	0.091	04/11/17 11:07	
Barium, Dissolved	ug/L	ND	0.30	0.019	04/11/17 11:07	
Beryllium, Dissolved	ug/L	ND	0.20	0.030	04/11/17 11:07	
Cadmium, Dissolved	ug/L	ND	0.080	0.013	04/11/17 11:07	
Chromium, Dissolved	ug/L	ND	0.50	0.14	04/11/17 11:07	
Cobalt, Dissolved	ug/L	ND	0.50	0.021	04/11/17 11:07	
Copper, Dissolved	ug/L	ND	1.0	0.40	04/11/17 11:07	
Iron, Dissolved	ug/L	ND	50.0	18.5	04/11/17 11:07	
Lead, Dissolved	ug/L	0.012J	0.10	0.012	04/11/17 11:07	
Nickel, Dissolved	ug/L	ND	0.50	0.099	04/11/17 11:07	
Selenium, Dissolved	ug/L	ND	0.50	0.13	04/11/17 11:07	
Vanadium, Dissolved	ug/L	ND	1.0	0.085	04/11/17 11:07	
Zinc, Dissolved	ug/L	ND	5.0	0.78	04/11/17 11:07	

LABORATORY CONTROL SAMPLE: 2555323

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Antimony, Dissolved	ug/L	100	101	101	85-115	
Arsenic, Dissolved	ug/L	100	102	102	85-115	
Barium, Dissolved	ug/L	100	100	100	85-115	
Beryllium, Dissolved	ug/L	100	106	106	85-115	
Cadmium, Dissolved	ug/L	100	102	102	85-115	
Chromium, Dissolved	ug/L	100	105	105	85-115	
Cobalt, Dissolved	ug/L	100	98.5	98	85-115	
Copper, Dissolved	ug/L	100	97.6	98	85-115	
Iron, Dissolved	ug/L	2000	2040	102	85-115	
Lead, Dissolved	ug/L	100	99.7	100	85-115	
Nickel, Dissolved	ug/L	100	101	101	85-115	
Selenium, Dissolved	ug/L	100	104	104	85-115	
Vanadium, Dissolved	ug/L	100	102	102	85-115	
Zinc, Dissolved	ug/L	100	106	106	85-115	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2555324 2555325

Parameter	Units	10383803002 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Antimony, Dissolved	ug/L	ND	100	100	102	98.8	102	99	70-130	3	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2555324 2555325

Parameter	Units	10383803002 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic, Dissolved	ug/L	ND	100	100	102	98.9	102	99	70-130	3	20	
Barium, Dissolved	ug/L	6.8	100	100	108	105	101	99	70-130	2	20	
Beryllium, Dissolved	ug/L	ND	100	100	101	102	101	102	70-130	1	20	
Cadmium, Dissolved	ug/L	ND	100	100	103	100	103	100	70-130	2	20	
Chromium, Dissolved	ug/L	ND	100	100	102	101	102	101	70-130	1	20	
Cobalt, Dissolved	ug/L	ND	100	100	94.5	94.3	94	94	70-130	0	20	
Copper, Dissolved	ug/L	1.2	100	100	97.9	96.8	97	96	70-130	1	20	
Iron, Dissolved	ug/L	ND	2000	2000	2000	2000	100	100	70-130	0	20	
Lead, Dissolved	ug/L	ND	100	100	95.6	94.7	96	95	70-130	1	20	
Nickel, Dissolved	ug/L	0.61	100	100	99.0	97.3	98	97	70-130	2	20	
Selenium, Dissolved	ug/L	ND	100	100	101	100	101	100	70-130	1	20	
Vanadium, Dissolved	ug/L	ND	100	100	104	100	104	100	70-130	4	20	
Zinc, Dissolved	ug/L	15.2	100	100	123	119	107	103	70-130	3	20	

MATRIX SPIKE SAMPLE: 2555326

Parameter	Units	10384264004 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
Antimony, Dissolved	ug/L	ND	100	103	103	70-130	
Arsenic, Dissolved	ug/L	ND	100	102	102	70-130	
Barium, Dissolved	ug/L	0.037J	100	101	101	70-130	
Beryllium, Dissolved	ug/L	ND	100	103	103	70-130	
Cadmium, Dissolved	ug/L	ND	100	103	103	70-130	
Chromium, Dissolved	ug/L	0.26J	100	103	103	70-130	
Cobalt, Dissolved	ug/L	ND	100	96.2	96	70-130	
Copper, Dissolved	ug/L	ND	100	97.9	98	70-130	
Iron, Dissolved	ug/L	ND	2000	2030	101	70-130	
Lead, Dissolved	ug/L	ND	100	99.6	100	70-130	
Nickel, Dissolved	ug/L	ND	100	101	101	70-130	
Selenium, Dissolved	ug/L	ND	100	103	103	70-130	
Vanadium, Dissolved	ug/L	ND	100	100	100	70-130	
Zinc, Dissolved	ug/L	ND	100	106	106	70-130	

QUALITY CONTROL DATA

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

QC Batch: 468860
Analysis Method: EPA 120.1
QC Batch Method: EPA 120.1
Analysis Description: 120.1 Specific Conductance
Associated Lab Samples: 10384264001, 10384264002, 10384264003

METHOD BLANK: 2560835
Matrix: Water
Associated Lab Samples: 10384264001, 10384264002, 10384264003

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Specific Conductance	umhos/cm	ND	1.0	1.0	04/17/17 10:05	

LABORATORY CONTROL SAMPLE: 2560836

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Specific Conductance	umhos/cm	1000	943	94	90-110	

SAMPLE DUPLICATE: 2560837

Parameter	Units	10383965009 Result	Dup Result	RPD	Max RPD	Qualifiers
Specific Conductance	umhos/cm	340	335	1	20	

SAMPLE DUPLICATE: 2560838

Parameter	Units	10383927001 Result	Dup Result	RPD	Max RPD	Qualifiers
Specific Conductance	umhos/cm	1840	1820	1	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

QC Batch: 468900
QC Batch Method: EPA 120.1
Associated Lab Samples: 10384264004

Analysis Method: EPA 120.1
Analysis Description: 120.1 Specific Conductance

METHOD BLANK: 2560950
Matrix: Water
Associated Lab Samples: 10384264004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Specific Conductance	umhos/cm	ND	1.0	1.0	04/18/17 11:25	

LABORATORY CONTROL SAMPLE: 2560951

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Specific Conductance	umhos/cm	1000	933	93	90-110	

SAMPLE DUPLICATE: 2560952

Parameter	Units	10385165002 Result	Dup Result	RPD	Max RPD	Qualifiers
Specific Conductance	umhos/cm	1510	1480	2	20	

SAMPLE DUPLICATE: 2560953

Parameter	Units	10384707002 Result	Dup Result	RPD	Max RPD	Qualifiers
Specific Conductance	umhos/cm	2750	2780	1	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

QC Batch: 469460
Analysis Method: SM 4500-H+B
QC Batch Method: SM 4500-H+B
Analysis Description: 4500H+B pH
Associated Lab Samples: 10384264001, 10384264002, 10384264003, 10384264004

LABORATORY CONTROL SAMPLE: 2563418

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
pH at 25 Degrees C	Std. Units	5	5.1	101	98-102	H6

SAMPLE DUPLICATE: 2563419

Parameter	Units	10384255002 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	7.0	7.0	0	3	H6

SAMPLE DUPLICATE: 2563420

Parameter	Units	10383931001 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	7.5	7.4	1	3	H6

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

QC Batch: 468337
QC Batch Method: ASTM D516
Analysis Method: ASTM D516
Analysis Description: ASTM D516 Sulfate Water
Associated Lab Samples: 10384264001, 10384264002, 10384264003, 10384264004

METHOD BLANK: 2557790
Matrix: Water
Associated Lab Samples: 10384264001, 10384264002, 10384264003, 10384264004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Sulfate	mg/L	ND	2.5	1.0	04/13/17 15:09	

LABORATORY CONTROL SAMPLE & LCSD: 2557791 2557792

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Sulfate	mg/L	7.5	8.3	8.1	111	109	80-120	2	20	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2557793 2557794

Parameter	Units	10383897001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Sulfate	mg/L	ND	20	20	21.1	21.5	103	105	80-120	2	30	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2557795 2557796

Parameter	Units	10384466004 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Sulfate	mg/L	71.8	20	20	88.8	87.1	85	76	80-120	2	30	M1

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

QC Batch: 469071
QC Batch Method: SM 4500-Cl E
Analysis Method: SM 4500-Cl E
Analysis Description: SM4500Cl-E Chloride
Associated Lab Samples: 10384264001, 10384264002, 10384264003, 10384264004

METHOD BLANK: 2561557
Matrix: Water
Associated Lab Samples: 10384264001, 10384264002, 10384264003, 10384264004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Chloride	mg/L	ND	1.0	0.45	04/18/17 11:11	FS

LABORATORY CONTROL SAMPLE: 2561558

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Chloride	mg/L	15	15.0	100	90-110	FS

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2561559 2561560

Parameter	Units	10384255003 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	81.4	15	15	94.4	95.1	87	92	80-120	1	30	FS

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2561561 2561562

Parameter	Units	10384466004 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	28.7	15	15	43.0	42.3	96	91	80-120	2	30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALIFIERS

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above adjusted reporting limit.

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

LABORATORIES

PASI-M	Pace Analytical Services - Minneapolis

ANALYTE QUALIFIERS

B	Analyte was detected in the associated method blank.
FS	The sample was filtered in the laboratory prior to analysis.
H6	Analysis initiated outside of the 15 minute EPA required holding time.
M1	Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: Old Landfill/Clark Tellings
Pace Project No.: 10384264

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
10384264001	BSB-GW-06	EPA 200.8	467722	EPA 200.8	467841
10384264002	BSB-GW-05	EPA 200.8	467722	EPA 200.8	467841
10384264003	BSB-GW-08	EPA 200.8	467722	EPA 200.8	467841
10384264004	BSB-GW-09	EPA 200.8	467722	EPA 200.8	467841
10384264001	BSB-GW-06	EPA 120.1	468860		
10384264002	BSB-GW-05	EPA 120.1	468860		
10384264003	BSB-GW-08	EPA 120.1	468860		
10384264004	BSB-GW-09	EPA 120.1	468900		
10384264001	BSB-GW-06	SM 4500-H+B	469460		
10384264002	BSB-GW-05	SM 4500-H+B	469460		
10384264003	BSB-GW-08	SM 4500-H+B	469460		
10384264004	BSB-GW-09	SM 4500-H+B	469460		
10384264001	BSB-GW-06	ASTM D516	468337		
10384264002	BSB-GW-05	ASTM D516	468337		
10384264003	BSB-GW-08	ASTM D516	468337		
10384264004	BSB-GW-09	ASTM D516	468337		
10384264001	BSB-GW-06	SM 4500-Cl E	469071		
10384264002	BSB-GW-05	SM 4500-Cl E	469071		
10384264003	BSB-GW-08	SM 4500-Cl E	469071		
10384264004	BSB-GW-09	SM 4500-Cl E	469071		

bp rm

Laboratory Management Program LaMP Chain of Custody Record

Page 1 of 1

BP Site Node Path:
BP Facility No: Old Landfill/Clark Tailings
Req Due Date (mm/dd/yy): 04/06/17 Rush TAT: Yes ___ No X
Lab Work Order Number:

Lab Name: Pace Analytical Services	Facility Address:	Consultant/Contractor: Pioneer Technical Services, Inc.
Lab Address: 1700 Elm Street Minneapolis, MN 55414	City, State, ZIP Code: Butte	Consultant/Contractor Project No:
Lab PM: Bob Michels	Lead Regulatory Agency:	Address: 1101 S. Montana St., Butte, MT 59701
Lab Phone: Office: 612-607-6452	California Global ID No.:	Consultant/Contractor PM: Vanessa Armstrong
Lab Shipping Accnt:	Enfos Proposal No:	Phone: 406-782-5177 Email: varmstrong@pioneer-technical.com
Lab Bottle Order No:	Accounting Mode: Provision ___ OOC-BU ___ OOC-RM ___	Email EDD To: and to lab.enfosdoc@bp.com
Other Info:	Stage: Activity:	Invoice To: BP X Contractor ___

BP Project Manager (PM):
BP PM Phone:
BP PM Email:

Report Type & QC Level
Standard X
Full Data Package ___

				Matrix				No. Containers / Preservative							Requested Analyses											
Lab No.	Sample Description	Date	Time	Soil / Solid	Water / Liquid	Air / Vapor	Is this location a well?	Total Number of Containers	Unpreserved	H_2SO_4	HNO_3	HCl	Methanol		Dissolved Metals method 200.8	(Sb, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb,	Ni, Se, V, Zn)	pH, SC, Chloride, SO4							Note: If sample not collected, indicate "No Sample" in comments and single-strike out and initial any preprinted sample description.
	BSB-GW-06	4/6/17	1137		X				2		1				X			X							001
	BSB-GW-05	4/6/17	1250		X				2		1				X			X							002
	BSB-GW-08	4/6/17	1257		X				2		1				X			X							003
	BSB-GW-09	4/6/17	1410		X				2		1				X			X							004

Sampler's Name: Vanessa Armstrong	Relinquished By / Affiliation	Date	Time	Accepted By / Affiliation	Date	Time
Sampler's Company: Pioneer Technical Services	Vanessa Armstrong / Pioneer	4/6/17	1510	[illegible] Pace	4/7/17	945
Shipment Method: FedEx Overnight Ship Date: 4/6/2017						
Shipment Tracking No:						

Special Instructions:

THIS LINE - LAB USE ONLY: Custody Seals In Place: [✓ Yes] / No | Temp Blank: [✓ Yes] / No | Cooler Temp on Receipt: 1.7 °F/C | Trip Blank: Yes / [✓ No] | MS/MSD Sample Submitted: Yes / [✓ No]

BP Remediation Management COC - Effective Date: starting August 16, 2011.

BP LaMP COC Rev. 8, 24 June 2012

Pace Analytical®	Document Name: **Sample Condition Upon Receipt Form - ESI**	Document Revised: 21Dec2016 Page 1 of 2
	Document No.: F-MN-L-210-rev.22	Issuing Authority: Pace Minnesota Quality Office

Sample Condition Upon Receipt – ESI Tech Specs

Client Name: BP - Pioneer Tech

Project #:

WO# : 10384264

10384264

Courier: ☒Fed Ex ☐UPS ☐USPS ☐Client ☐Commercial ☐Pace ☐SpeeDee ☐Other:

Tracking Number: 709633726081

Custody Seal on Cooler/Box Present? ☒Yes ☒No BL 4/7/17 **Seals Intact?** ☒Yes ☐No

Optional: Proj. Due Date: Proj. Name:

Packing Material: ☐Bubble Wrap ☐Bubble Bags ☒None ☐Other: **Temp Blank?** ☒Yes ☐No

Thermometer Used: ☒ 151401163 ☐ 151401164 **Type of Ice:** ☒Wet ☐Blue ☐None ☐Samples on ice, cooling process has begun

Cooler Temp Read (°C): 1.5 **Cooler Temp Corrected (°C):** 1.7 **Biological Tissue Frozen?** ☐Yes ☐No ☒NA

Temp should be above freezing to 6°C **Correction Factor:** +0.2 **Date and Initials of Person Examining Contents:** BM 4/7/17

USDA Regulated Soil (☒N/A, water sample)

Did samples originate in a quarantine zone within the United States: AL, AR, CA, FL, GA, ID, LA. MS, NC, NM, NY, OK, OR, SC, TN, TX or VA (check maps)? ☐Yes ☐No

Did samples originate from a foreign source (internationally, including Hawaii and Puerto Rico)? ☐Yes ☐No

If Yes to either question, fill out a Regulated Soil Checklist (F-MN-Q-338) and include with SCUR/COC paperwork.

				COMMENTS:
Chain of Custody Present?	☒Yes	☐No		1.
Chain of Custody Filled Out?	☒Yes	☐No		2.
Chain of Custody Relinquished?	☒Yes	☐No		3.
Sampler Name and/or Signature on COC?	☒Yes	☐No	☐N/A	4.
Samples Arrived within Hold Time?	☒Yes	☐No		5.
Short Hold Time Analysis (<72 hr)?	☐Yes	☒No		6.
Rush Turn Around Time Requested?	☐Yes	☒No		7.
Sufficient Volume (triple volume provided for MS/MSD)?	☐Yes	☒No		8. No MS/MSD Requested
Correct Containers Used? -Pace Containers Used?	☒Yes ☒Yes	☐No ☐No		9.
Containers Intact?	☒Yes	☐No		10.
Filtered Volume Received for Dissolved Tests?	☒Yes	☐No	☐N/A	11. Note if sediment is visible in the dissolved container.
Sample Labels Match COC? -Includes Date/Time/ID/Analysis Matrix: WT	☒Yes	☐No		12.
All containers needing acid/base preservation have been checked?	☒Yes	☐No	☐N/A	13. ☒HNO₃ 1/1 ☐H₂SO₄ ☐NaOH Positive for Res. Chlorine? Y N
All containers needing preservation are found to be in compliance with EPA recommendation? (HNO₃, H₂SO₄, NaOH>9 Sulfide, NaOH>12 Cyanide)	☒Yes	☐No	☐N/A	Sample # 1-4
Exceptions: VOA, Coliform, TOC/DOC, Oil and Grease, DRO/8015 (water) and Dioxin. Per method, VOA pH is checked after analysis	☐Yes	☐No	☒N/A	Initial when completed: Lot # of added preservative:
Headspace in VOA Vials (>6mm)?	☐Yes	☐No	☒N/A	14.
3 Trip Blanks Present?	☐Yes	☐No	☒N/A	15.
Trip Blank Custody Seals Present?	☐Yes	☐No	☒N/A	
Pace Trip Blank Lot # (if purchased):				

CLIENT NOTIFICATION/RESOLUTION **Field Data Required?** ☐Yes ☐No

Person Contacted: Date/Time:

Comments/Resolution:

Temp Log: Temp must be maintained at <6°C during login, record temp every 20 mins		
Opened Time: 16:05	Temp: 1.5	Corrected Temp: 1.7
Time: 16:10 put in cooler		
Time:	Temp:	Corrected Temp:

Project Manager Review: BM **Date:** 4/7/17

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers)

PIONEER
TECHNICAL SERVICES, INC.

ßl

RECEIVED
DEC 19 2016
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

#20

December 16, 2016

Mr. John Collins
Montana DEQ/Solid Waste Program
P.O. Box 200901
Helena, Montana 59620-0901

RE: Old Butte-Silver Bow County Landfill/Clark Tailings

Dear John:

Enclosed are results from the Old Butte-Silver Bow County Landfill/Clark Tailings September 2016 semi-annual groundwater monitoring event. The following have been included for your information:

- September 2016 sampling summary;
- Table 1 analytical data summary;
- Table oldlfctSeptSTX16 (non-parametric comparison of wells) (is provided electronically on the CD);
- Groundwater field parameters collected in the field;
- Copy of field notes;
- Trend graphs of detected compounds;
- Groundwater potentiometric surface map for September 2016; and
- Analytical data from Pace Laboratories in Minneapolis, Minnesota.

The calculated Confidence Level of 97.9 % was found using the formula n/(n+k), where n is the total number of background samples collected and k is the number of future sampling events (Section 4.2.1 Non-Parametric Prediction Intervals, Pages 61-63 and Table A-7, Appendix A; Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities; Addendum to Interim Final Guidance; and Office of Solid Waste Permits and State Programs Division, U.S. EPA, July 1992).

The groundwater velocity was calculated using Darcy's Law and the equation for the seepage velocity. The average groundwater velocity for September 2016 sampling event was 0.155 feet per day (ft/day). The hydraulic conductivity value used to calculate the groundwater velocity was obtained from the *Corrective Measures Assessment Report* (Pioneer, 2009) and from the March 2009 pumping data.

Sincerely,

Vanessa Armstrong
Staff Engineer

Encl.

cc. Dave Schultz, BSB Landfill Manager
Mitch Mihailovich, Pioneer
Loren Burmeister, Atlantic Richfield (electronic copy)
Cord Harris, Atlantic Richfield (w/o enc. – email)
Irene Montero, Atlantic Richfield (w/o enc. – email)
70.04.25.16 – MiningSharePoint@bp.com

ATTACHMENTS

TABLE

Old Butte-Silver Bow County Landfill
GROUNDWATER FIELD CHEMISTRY RESULTS AND PURGE VOLUMES
September-16

Well I.D.	Sample #	Depth (ft)	Radius (ft)	S.W.L. (ft)	TOC Elevation (ft)	Groundwater Elevation (ft)	pH. (su)	E.h. (mV)	S.C. (uS/cm)	T (Celsius)	Sample Time	H2O Volume Req'd (gal)	H2O Volume Purged (gal)	Comments
MBMG-2	BSB-GW-01	23.2	0.17	15.48	5529.88	5514.40	7.14	-150.6	1982	10.0	10:37	4.00	8.00	
BSB-A1	BSB-GW-02	52.53	0.17	37.27	5531.50	5494.23	7.11	-345.1	1989	10.5	12:23	9.80	10.00	
BSB-A5	BSB-GW-03	45.60	0.17	42.78	5524.62	5481.84	6.42	-268.40	1888.00	11.30	0.54	1.40	1.50	
BSB-A6-R	BSB-GW-04	59.75	0.17	52.39	5554.41	5502.02	6.21	-323.6	1709	11.3	14:25	3.67	5.40	
BSB-A6-R	BSB-GW-07	59.75	0.17	52.39	5554.41	5502.02	6.21	-323.6	1709	11.3	14:25	3.67	5.40	VOC Duplicate
CLK-1	BSB-GW-05	19.00	0.17	5.44	5478.73	5473.29	6.11	-330.0	1968	10.7	11:10	7.73	10.00	
CLK-2	BSB-GW-06	46.90	0.17	41.19	5511.17	5469.98	6.17	-150.3	1835	11.0	10:20	2.75	3.90	
CLK-2	BSB-GW-08	46.90	0.17	41.19	5511.17	5469.98	6.17	-150.3	1835	11.0	10:20	2.75	3.90	Raw, DM Duplicate
Blank	BSB-GW-09	NA	NA	NA	NA	NA	NA	NA	NA	NA	10:25	NA	NA	Field Blank

KEY:

NA	Measurement Not Taken
SA	Sample Not Taken

SAMPLE NUMBER WELL ANALYTE (units):	BSB-GW-O1 MBMG-2	BSB-(BSI	8 E	BSB-GW-09 Field Blank Trip Blank	GW PROTECTION STANDARDS USEPA MCL*	 MONTANA HHS
DISSOLVED METALS (mg/L)						
Antimony	(Pace 0.00026 J)< 0.0005		005	< 0.0005	0.006	0.014
Arsenic	0.0012		600	< 0.0005	0.05	0.01
Barium	0.16		22	(Pace 0.000057 J)< 0.0003	2	2
Beryllium	< 0.00020		0033	< 0.0002	0.004	0.004
Cadmium	(Pace 0.000020 J)< 0.00008		100	< 0.00008	0.005	0.005
Chromium	(Pace 0.00028 J)< 0.0005		0050	< 0.0005	0.1	0.1
Cobalt	(Pace 0.00028 J)< 0.0005		3500	< 0.0005	---	---
Copper	0.0012		010	0.001	1.3 (a)	1.3
Iron	< 0.05		800	0.050	0.3(s)	0.3
Lead	< 0.00010		0010	(Pace 0.000013 J)< 0.0001	0.015 (a)	0.015
Mercury	SA			NR	0.002	0.002
Nickel	(Pace 0.00018 J)< 0.0005		310	< 0.0005	0.1	0.1
Selenium	0.00072		005	< 0.0005	0.05	0.05
Silver	NR		R	NR	0.1	0.1
Thallium	NR		R	NR	0.002	0.002
Tin	NR		R	NR		
Vanadium	0.0062		010	< 0.001	---	---
Zinc	(Pace 0.0043 J)< 0.0050		.400	(Pace 0.0014 J)< 0.005	5	2
INORGANICS (mg/L)						
Chloride	80		.1	< 1.0	250	---
COD	(Pace 12.5 J)< 50.0		R	SA	---	---
Conductivity (umhos/cm)	896		60	1.1	---	---
Cyanide	< 0.010		R	NR	---	0.2
Nitrate\Nitrite - N	2.4		R	NR	10	10
pH	6.7		2	7.7		
Sulfate	184		8	(Pace 1.3 J)< 2.5	250	---
Sulfide	SA		R	NR		
EPA METHOD 8260 (ug/L)						
Acetone	< 20.0		A	SA	---	---
Benzene	< 1.0		A	SA	5	5
Carbon Disulfide	< 1.0		A	SA	---	---
Chloroethane	< 1.0		A	SA	---	---
Chloroform	(Pace 0.23 J)< 1.0		A	SA	---	70
Chlormethane	< 4.0		A	SA	---	---
1,4-Dichlorobenzene	< 1.0		A	SA	75	75
Dichlorodiflouromethane	< 1.0		A	SA	---	1000
1,1-Dichloroethane	< 1.0		A	SA	---	---
1,2-Dichloroethane	< 1.0		A	SA	5	4
cis-1,2-Dichloroethene	< 1.0	(Pace 0.78 J	A	SA	70	70
trans-1,2-Dichloroethene	< 1.0		A	SA	100	100
Ethylbenzene	< 1.0		A	SA		
1,2-Dichloropropane	< 4.0		A	SA	5	5
4-Isopropyltoluene	NR		A	SA	---	---
Methylene Chloride	< 4.0		A	SA	5	30
Naphthalene	NR		A	SA	---	100
Tetrachloroethene	< 1.0	(Pace 0.32 J	A	SA	5	5
Trichloroethene	< 0.4		A	SA	5	5
1,2,4-Trimethylbenzene	NR		A	SA	---	---
Vinyl Chloride	< 0.4		A	SA	2	0.2
EPA METHOD 8270 (ug/L)						
bis(2-ethylhexyl)Phthalate	SA		A	SA	6	6
EPA METHOD 8151 (ug/L)						
Picloram	SA		A	SA		
Dicamba	SA		A	SA		
2,4,5-TP (Silvex)	SA		A	SA		
2,4-D	SA		A	SA		
EPA METHOD 8081 (ug/L)	SA		A	SA		
EPA METHOD 8082 (ug/L)	SA		A	SA		

* MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
NA = Not enough sample available for analysis
NR = Analysis Not Requested
ND = Analyte Not Detected
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
NS= Sample Not Collected (Dry Well-BSB-A5)
SA = Sample Not Taken

TABLE I: ANALYTICAL DATA FOR GROUNDWATER SAMPLES, OLD SILVER BOW COUNTY LANDFILl
DATE SAMPLED: September 7 & 8, 2016

SAMPLE NUMBER WELL ANALYTE (units):	BSB-GW-O1 MBMG-2	BSB-GW-O2 BSB-A1	BSB-GW-O3 BSB-A5	BSB-GW-O4 BSB-A6-R	BSB-GW-O5 CLK-1	BSB-GW-O6 CLK-2	BSB-GW-07 BSB-A6R DUPE	BSB-GW-08 CLK-1 DUPE	BSB-GW-09 Field Blank Trip Blank	GW PROTECTION STANDARDS	
										USEPA MCL*	MONTANA HHS
DISSOLVED METALS (mg/L)											
Antimony	(Pace 0.00026 J)< 0.0005	SA	SA	SA	(Pace 0.00036 J)< 0.0005	(Pace 0.00019 J)< 0.0005	SA	(Pace 0.00018 J)< 0.0005	< 0.0005	0.006	0.014
Arsenic	0.0012	SA	SA	SA	0.150	0.0011	SA	0.1600	< 0.0005	0.05	0.01
Barium	0.16	SA	SA	SA	0.022	0.017	SA	0.022	(Pace 0.000057 J)< 0.0003	2	2
Beryllium	< 0.00020	SA	SA	SA	0.00037	< 0.0002	SA	0.00033	< 0.0002	0.004	0.004
Cadmium	(Pace 0.000020 J)< 0.00008	SA	SA	SA	0.01	0.0014	SA	0.0100	< 0.00008	0.005	0.005
Chromium	(Pace 0.00028 J)< 0.0005	SA	SA	SA	(Pace 0.00025 J)< 0.0005	(Pace 0.00027 J)< 0.0005	SA	< 0.00050	< 0.0005	0.1	0.1
Cobalt	(Pace 0.00028 J)< 0.0005	SA	SA	SA	0.035	(Pace 0.00048 J)< 0.0005	SA	0.03500	< 0.0005	- - -	- - -
Copper	0.0012	SA	SA	SA	(Pace 0.00081 J)< 0.0010	0.0019	SA	(Pace 0.00069 J)< 0.0010	0.001	1.3 (a)	1.3
Iron	< 0.05	SA	SA	SA	13.4	< 0.050	SA	13.800	0.050	0.3(s)	0.3
Lead	< 0.00010	SA	SA	SA	0.00012	(Pace 0.00049 J)< 0.00010	SA	(Pace 0.000037 J)< 0.00010	(Pace 0.000013 J)< 0.0001	0.015 (a)	0.015
Mercury	SA	SA	SA	SA	SA	SA	SA	SA	NR	0.002	0.002
Nickel	(Pace 0.00018 J)< 0.0005	SA	SA	SA	0.0300	0.0550	SA	0.0310	< 0.0005	0.1	0.1
Selenium	0.00072	SA	SA	SA	(Pace 0.00016 J)< 0.0005	(Pace 0.00015 J)< 0.0005	SA	< 0.0005	< 0.0005	0.05	0.05
Silver	NR	SA	SA	SA	NR	NR	SA	NR	NR	0.1	0.1
Thallium	NR	SA	SA	SA	NR	NR	SA	NR	NR	0.002	0.002
Tin	NR	SA	SA	SA	NR	NR	SA	NR	NR		
Vanadium	0.0062	SA	SA	SA	(Pace 0.00040 J)< 0.001	0.0022	SA	(Pace 0.00030 J)< 0.0010	< 0.001	- - -	- - -
Zinc	(Pace 0.0043 J)< 0.0050	SA	SA	SA	37.6	0.780	SA	38.400	(Pace 0.0014 J)< 0.005	5	2
INORGANICS (mg/L)											
Chloride	80	20.9	36.6	83.2	33.4	66.9	SA	33.1	< 1.0	250	- - -
COD	(Pace 12.5 J)< 50.0	< 50.0	(Pace 10.0 J)< 50.0	518	NR	NR	SA	NR	SA	- - -	- - -
Conductivity (umhos/cm)	896	530	1390	2700	1480	1660	SA	1460	1.1	- - -	- - -
Cyanide	< 0.010	> 0.010	> 0.010	(Pace 0.01 J)< 0.010	NR	NR	SA	NR	NR	- - -	0.2
Nitrate\Nitrite - N	2.4	0.27	0.55	0.39	NR	NR	SA	NR	NR	10	10
pH	6.7	6.7	5.9	5.6	6.2	6.4	SA	6.2	7.7		
Sulfate	184	102	692	1220	623	700	SA	618	(Pace 1.3 J)< 2.5	250	- - -
Sulfide	SA	SA	SA	SA	NR	NR	SA	NR	NR		
EPA METHOD 8260 (ug/L)											
Acetone	< 20.0	< 20.0	< 20.0	(Pace 6.6 J)< 20.0	SA	SA	(Pace 6.8 J)< 20.0	SA	SA	- - -	- - -
Benzene	< 1.0	< 1.0	< 1.0	(Pace 0.50 J)< 1.0	SA	SA	(Pace 0.46 J)< 1.0	SA	SA	5	5
Carbon Disulfide	< 1.0	< 1.0	< 1.0	< 1.0	SA	SA	< 1.0	SA	SA	- - -	- - -
Chloroethane	< 1.0	< 1.0	< 1.0	< 1.0	SA	SA	< 1.0	SA	SA	- - -	- - -
Chloroform	(Pace 0.23 J)< 1.0	< 1.0	< 1.0	< 1.0	SA	SA	< 1.0	SA	SA	- - -	70
Chlormethane	< 4.0	< 4.0	< 4.0	< 4.0	SA	SA	< 4.0	SA	SA	- - -	- - -
1,4-Dichlorobenzene	< 1.0	< 1.0	< 1.0	1.3	SA	SA	1.5	SA	SA	75	75
Dichlorodiflouromethane	< 1.0	< 1.0	< 1.0	1.3	SA	SA	1.4	SA	SA	- - -	1000
1,1-Dichloroethane	< 1.0	< 1.0	< 1.0	1.4	SA	SA	1.5	SA	SA	- - -	- - -
1,2-Dichloroethane	< 1.0	< 1.0	(Pace 0.57 J)< 1.0	< 1.0	SA	SA	< 1.0	SA	SA	5	4
cis-1,2-Dichloroethene	< 1.0	(Pace 0.78 J)< 1.0	2.4	2.3	SA	SA	2.2	SA	SA	70	70
trans-1,2-Dichloroethene	< 1.0	< 1.0	< 1.0	< 1.0	SA	SA	< 1.0	SA	SA	100	100
Ethylbenzene	< 1.0	< 1.0	< 1.0	< 1.0	SA	SA	< 1.0	SA	SA		
1,2-Dichloropropane	< 4.0	< 4.0	< 4.0	(Pace 0.60 J)< 4.0	SA	SA	(Pace 0.55 J)< 4.0	SA	SA	5	5
4-Isopropyltoluene	NR	NR	NR	NR	SA	SA	NR	SA	SA	- - -	- - -
Methylene Chloride	< 4.0	< 4.0	< 4.0	(Pace 0.46 J)< 4.0	SA	SA	< 4.0	SA	SA	5	30
Naphthalene	NR	NR	NR	NR	SA	SA	NR	SA	SA	- - -	100
Tetrachloroethene	< 1.0	(Pace 0.32 J)< 1.0	(Pace 0.80 J)< 1.0	< 1.0	SA	SA	< 1.0	SA	SA	5	5
Trichloroethene	< 0.4	< 0.4	(Pace 0.29 J)< 0.4	(Pace 0.21 J)< 0.4	SA	SA	< 0.4	SA	SA	5	5
1,2,4-Trimethylbenzene	NR	NR	NR	NR	SA	SA	NR	SA	SA	- - -	- - -
Vinyl Chloride	< 0.4	< 0.4	< 0.4	1.4	SA	SA	1.5	SA	SA	2	0.2
EPA METHOD 8270 (ug/L)											
bis(2-ethylhexyl)Phthalate	SA	SA	SA	SA	SA	SA	SA	SA	SA	6	6
EPA METHOD 8151 (ug/L)											
Picloram	SA	SA	SA	SA	SA	SA	SA	SA	SA		
Dicamba	SA	SA	SA	SA	SA	SA	SA	SA	SA		
2,4,5-TP (Silvex)	SA	SA	SA	SA	SA	SA	SA	SA	SA		
2,4-D	SA	SA	SA	SA	SA	SA	SA	SA	SA		
EPA METHOD 8081 (ug/L)	SA	SA	SA	SA	SA	SA	SA	SA	SA		
EPA METHOD 8082 (ug/L)	SA	SA	SA	SA	SA	SA	SA	SA	SA		

* MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
NA = Not enough sample available for analysis
NR = Analysis Not Requested
ND = Analyte Not Detected
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
NS= Sample Not Collected (Dry Well-BSB-A5)
SA = Sample Not Taken

FIELD DATA SHEETS & NOTES

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old Landfill
WELL/STATION MTSMG-2 DATE 9/7/16 TIME 0950
SAMPLERS TSM, VA WEATHER CONDITIONS Cloudy, 50°F
PHOTO: Yes ______ No X ROLL# ______ NUMBER ______

PURGE DATA:

PURGE METHOD 12 volt
START PURGING 10:05
PURGE RATE ______ ~~GPM~~ 1 L/min
RATE CHANGE 1) Time ______ Rate ______
2) Time ______ Rate ______
SAMPLE TIME RA ~~BSB-GW-01~~ 1037

WELL DEPTH 23.25 Feet
DEPTH TO WATER 15.48 Feet
COLUMN DEPTH 7.77 Feet
CASING DIAMETER 2" Inch
PUMP SET AT 21' Feet
3 WELL VOLUMES 4 Gallons
TOTAL PURGE VOLUME 8g Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-01	250ml	✓	HNO_3	dissolved metals
"	250ml	H_2SO_4		NO_2/NO_3, COD
"	250ml	NaOH		Cyanide
"	500ml	Raw		pH, SC, Cl, SO_4^{-2}
"	40ml	HCl		8260B

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
10:28		10.0	7.23	1991	-158.7	4.88
10:30		9.9	7.14	2013	-155.6	4.79
10:32		9.9	7.20	1991	-153.7	4.69
10:34		9.9	7.16	1987	-151.9	4.67
10:36		10.0	7.14	1982	-150.6	4.74
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						

FIELD REMARKS: Water silty to start. Cleared after 2gal.

Pioneer Technical Services

FIELD SAMPLE DATA SHEET

Page 1 of

Project Name: Old landfill

WELL/STATION BSB-A1 DATE 9/7/16 TIME 1110

SAMPLERS BH, YSA WEATHER CONDITIONS partly cloudy, 52°F

PHOTO: Yes ____ No X ROLL# ____ NUMBER ____

PURGE DATA:

WELL DEPTH 57.0 Feet

DEPTH TO WATER 37.27 Feet

COLUMN DEPTH 19.73 Feet

CASING DIAMETER 2.0" Inch

PUMP SET AT 50' Feet

3 WELL VOLUMES ~~14.70~~ 9.8 Gallons

TOTAL PURGE VOLUME ~~14.9.5~~ 10 Gallons

PURGE METHOD SS Geosub pump

START PURGING 1143

PURGE RATE ____ GPM

RATE CHANGE 1) Time 1143 Rate 1L/min

2) Time ____ Rate ____

SAMPLE TIME 1223

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-02	~~250 ml~~		~~HNO_3~~	~~dissolved metals~~ YSA
↓	250 ml		H_2SO_4	NO_2/NO_3, COD
	250 ml		NaOH	Cyanide
	500 ml		Raw	pH, SC, Cl^-, SO_4^{-2}
	3-40ml		HCl	8260b

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
1210		10.6	7.24	1990	-355.0	0.26
1213		10.6	7.21	2000	-351.5	0.18
1215		10.5	7.14	1995	-344.2	0.12
1217		10.5	7.12	1991	-348.5	0.09
1219		10.5	7.11	1992	-347.9	0.09
1221		10.5	7.11	1989	-345.1	0.08
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						

FIELD REMARKS: Water is very silty; it did clear up after purging

Pioneer Technical Services

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old Landfill

WELL/STATION BSB-A5

DATE 9/7/16

TIME 1200

SAMPLERS BAt, Tst

WEATHER CONDITIONS partly cloudy; 52°F

PHOTO: Yes ______ No X

ROLL# ______

NUMBER ______

PURGE DATA:

PURGE METHOD Bailor

START PURGING 1207

PURGE RATE NA GPM

RATE CHANGE 1) Time ______ Rate ______

2) Time ______ Rate ______

SAMPLE TIME 1255

WELL DEPTH 45.60 Feet

DEPTH TO WATER 42.78 Feet

COLUMN DEPTH 2.82 Feet

CASING DIAMETER 2 in Inch

PUMP SET AT — Feet

3 WELL VOLUMES 1.4 Gallons

TOTAL PURGE VOLUME 1.5 Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-03	1-250ml		H_2SO_4	NO_2/NO_3, COD
↓	1-250ml		NaOH	Cyanide
↓	1-500ml		Raw	pH, SC, Cl^-, SO_4^{-2}
↓	3-40ml		HCl	8260b

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
1252		11.3	6.42	1888	-268.4	4.06
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						

FIELD REMARKS: Water-very dirty; silty

Pioneer Technical Services

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old Landfill
WELL/STATION BSB-A6-R DATE 9/7/16 TIME 1310
SAMPLERS ______ WEATHER CONDITIONS partly cloudy ~54°F
PHOTO: Yes ______ No X ROLL# ______ NUMBER ______

PURGE DATA:

PURGE METHOD SS Geosub pump
START PURGING 1340
PURGE RATE 1/2 L/min ~~GPM~~
RATE CHANGE 1) Time ______ Rate ______
2) Time ______ Rate ______
SAMPLE TIME 1425

WELL DEPTH 59.75 Feet
DEPTH TO WATER 52.39 Feet
COLUMN DEPTH 7.36 Feet
CASING DIAMETER 2 Inch
PUMP SET AT ~56' Feet
3 WELL VOLUMES 3.67 Gallons
TOTAL PURGE VOLUME 5.4 Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-04	1-250ml		H_2SO_4	NO_2/NO_3, COD
↓	1-250ml		NaOH	Cyanide
	1-500ml		RAW	pH, SC, Cl^-, SO_4^{-2}
	3-40ml		HCl	8260B

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
1415		12.5	6.20	1627	-346.4	0.23
1417		11.6	6.18	1685	-341.4	0.11
1419		11.3	6.20	1705	-331.4	0.08
1421		11.2	6.21	1704	-320.8	0.13
1423		11.3	6.21	1709	-323.6	0.16
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						

FIELD REMARKS: Sampled duplicate BSB-GW-07 for VOCs only collected 3-40ml pres. HCl. @ ~~1425~~ BA 1440

Pioneer Technical Services

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old landfill

WELL/STATION CLK-1 DATE 9/8/14 TIME 1035

SAMPLERS BH, BA WEATHER CONDITIONS partly cloudy, windy ~56°F

PHOTO: Yes ____ No ✓ ROLL# ____ NUMBER ____

PURGE DATA:

PURGE METHOD	12 Volt 3-Stage Submersible	WELL DEPTH	19.00 Feet
START PURGING	1042	DEPTH TO WATER	5.44 Feet TOP PVC
PURGE RATE	____ GPM 5 gals / 14 min	COLUMN DEPTH	13.56 Feet
RATE CHANGE	1) Time ____ Rate ____	CASING DIAMETER	2 in Inch
	2) Time ____ Rate ____	PUMP SET AT	~16 Feet
		3 WELL VOLUMES	7.73 Gallons
SAMPLE TIME	1110	TOTAL PURGE VOLUME	10 Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-05	1-250ml	✓	HNO_3	dissolved metals
	1-500ml		Raw	pH, SC, Cl^-, SO_4^{-2}

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
1052		10.3	6.06	1840	-292.8	0.15
1054		11.0	6.12	1855	-304.6	0.04
1056		11.1	6.11	1853	-309.9	0.04
1058		10.6	6.11	1879	-322.3	0.01
1100		10.5	6.11	1881	-320.2	0.00
1102		10.7	6.11	1869	-316.9	0.00
1104		10.5	6.10	1885	-325.9	0.00
1106		10.7	6.11	1868	-330.0	0.00
FINAL FIELD PARAMETERS PRIOR TO SAMPLING						

FIELD REMARKS: BSB-GW-08 - duplicate sample - 1-250ml HNO_3 - dissolved metals and 1-500ml Raw - pH, SC, Cl^-, SO_4^{-2}. Fairly large sediment. Water color is clear. @ 1135.

FIELD SAMPLE DATA SHEET

Page 1 of 1

Project Name: Old landfill

WELL/STATION CLK-2 DATE 9/8/16 TIME 0922

SAMPLERS BH, VA WEATHER CONDITIONS partly cloudy; 53 °F

PHOTO: Yes ______ No X ROLL# ______ NUMBER ______

PURGE DATA:

PURGE METHOD 12 V 3 stage submersible

START PURGING 1000

PURGE RATE L/min ~~GPM~~

RATE CHANGE 1) Time 1002 Rate 0.75 L/min

2) Time ______ Rate ______

SAMPLE TIME 1020

WELL DEPTH 46.90 Feet

DEPTH TO WATER 41.19 Feet

COLUMN DEPTH 5.71 Feet

CASING DIAMETER 2 Inch

PUMP SET AT ~44 Feet

3 WELL VOLUMES 2.75 Gallons

TOTAL PURGE VOLUME 3.9 Gallons

SAMPLE DATA:

SAMPLE #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
BSB-GW-06	1-250ml	✓	HNO_3	dissolved metals
	~~1-250ml~~		~~H_2SO_4~~	~~NO_2/NO_3, COD~~ VA
	~~1-250ml~~		~~NaOH~~	~~Cyanide~~ VA
	1-500ml		Raw	pH, SC, Cl^-, SO_4^{-2}
	~~3 4-40ml~~		~~HCL~~	~~8260~~ VA

FIELD PARAMATERS:

TIME	Amount Purged	Temp C	pH	S.C. um/cm	EH mv	D.O. mg/l
1005		10.8	6.06	1840	-189.3	1.92
1007		11.0	6.11	1838	-173.6	2.01
1009		11.1	6.18	1833	-153.1	3.98
1011		11.1	6.17	1831	-151.5	4.56
1013		11.0	6.17	1836	-148.0	4.65
1015		11.0	6.17	1835	-150.3	4.65

FINAL FIELD PARAMETERS PRIOR TO SAMPLING

FIELD REMARKS:

9/7/16
V. Armstrong
B. Hollamad.
Day Activities:
Sampling OLD LANDFILL.

Arrived @ MBMG-2 @ 0950.

Calibration of field meters.
4.01 → 4.00 pH
7.00 → 7.03
10.01 → 10.01
Average slope: 101.1%

Conductivity
1413 µS/cm → 1413
Avg. cell factor 1.00

ORP
219 → 211.9

Weather: ~~S~~ Cloudy ~45°F
DTW: 15.48 ft
Well depth: 23.25 ft
Column depth 7.77 ft
Casing diameter: 2 in.
Pump set @ 21 ft.
3 well volumes 4 gals

Total Volumes purged: 8 gals

Collected BSB-GW-01 @ 1037.
1-250 ml filtered HNO_3 - dissolved metals
1-250 ml H_2SO_4 - NO_2/NO_3 and COD
1-250 ml NaOH - cyanide
1-500ml Raw - pH, SC, Cl^-, SO_4^{-2}
3-40ml HCL - 8260b

Began purging @ 1005.
purged 4 gals.

Began field parameters @ 10:28. logged ~~s~~ results on field data ~~set~~ sheet.

Arrived @ BSB-A1 @ 1110.

Started purging @ 1143.
DTW: 37.27 ft
Well depth: 57.0 ft.
Column of water: 19.73 ft
Casing diameter: 2.0 in
Pump set at 50' ft
3 well volumes ~~10 gals~~ VEA 9.8 gals
total purged: 10 gals

Began field parameters @ 1210. logged results on data field sheet.

Collected BSB-GW-02 @ 1223.
1-250ml H_2SO_4 - NO_2/NO_3, COD
1-250ml NaOH - Cyanide
1-500ml RAW - pH, SC, Cl^-, SO_4^{-2}
3-40ml HCL - 8260b.

Arrived @ BSB-A5 @ 1238.

Well depth: 45.60'
DTW: 42.78'
Column depth: 2.82'
Casing diameter: 2"
Total purge volume: 1.5gal.
3 well volumes: 1.4 gals.
Started purging: 1207.

Took 1-field parameter data set; logged result on field data sheet.

Collected BSB-GW-03 @ 1255.
1-250ml H_2SO_4 - NO_2/NO_3, COD
1-250 ml NaOH - Cyanide

1-500ml Raw pH, SC, Cl^-, SO_4^{-2}
3-40ml HCL 8260b

Arrived @ BSB-A6-R @ 1310.
Well depth: 59.75'
DTW: 52.39'
Column ~~dia~~ depth: 7.36'
Casing diameter: 2"
pump set @ ~ 56'
3 well volumes: 3.67 gals
Total purged volume: 5.4 gals
Started purging @ 1340.
Began field parameters @ 1415; logged ~~results~~ results on field data sheet.

Collected BSB-GW-04 @ 1425.
1-250 ml H_2SO_4 - NO_2/NO_3, COD
1-250 ml NaOH - Cyanide
1-500 ml ~~HCl~~ Raw pH, SC, Cl^-, SO_4^{-2}
3-40 ml HCL 8260b.

Collected a duplicate sample BSB-GW-07 @ 1440.
3-40ml HCL 8260b.

Armstrong + Hollamon offsite @ 1455

9/8/16
Sampling OLD LANDFILL
Arrived @ CLK-2 @ 0922.
Calibrated Meters.
pH
4.01 → 4.00
7.00 → 7.03
10.01 → 10.10
Avg. slope: 99.7%

Conductivity: Conductivity could not be calibrated.
1413 → NA
avg. cell factor: Na

ORP: @ 17.6°C
219 → 207.9
Arrived @ CLK-~~2~~1 @ 1035.
Weather is ~~partly~~ partly cloudy ~56°F.
DTW: ~~19~~ 5.44 ft
TD: 19.00 ft
Column Depth: 13.56 ft
Casing diameter: 2in
Pump set @ ~16 ft
3 well volumes: 7.73 gals
Total Purged: 10 gals

Collected BSB-GW-05 @ 1110.
1-250 ml w/HNO3 - dissolved metals.
1-500 ml RAW - pH, SC, Cl⁻, SO_4^{-2}.

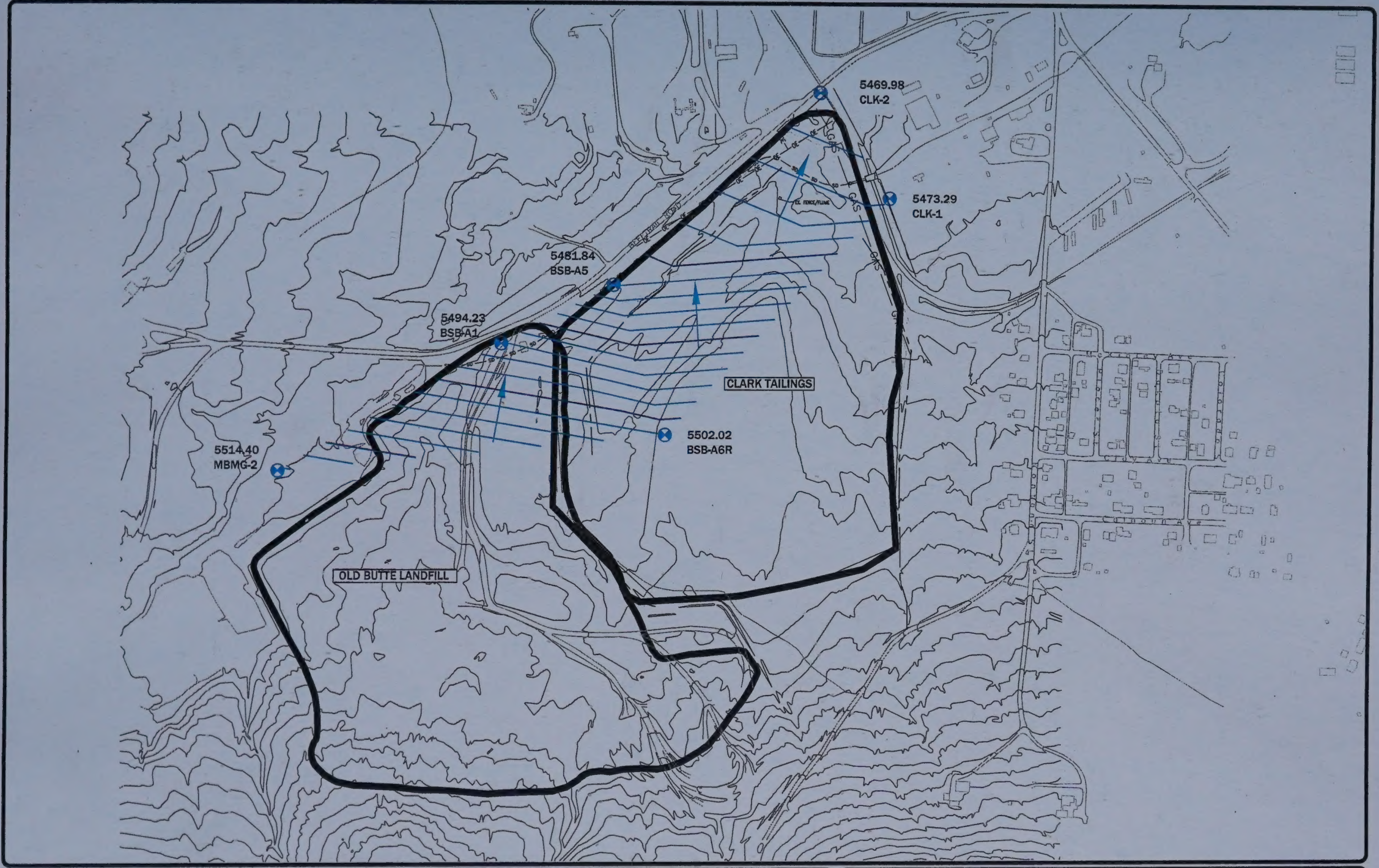
Collected duplicate Sample @ CLK-~~2~~.1
BSB-GW-08 @ 1125.
1-250mL w/HNO3 - dissolved metals
1-500ml RAW - pH, SC, Cl⁻, SO_4^{-2}

Arrived @ CLK-2 @ 0922.
DTW: 41.19 ft
TD: 46.90 ft
Column depth: 5.71 ft
Casing diameter: 2 in
Pump set @ ~44 ft
3 well volumes: 2.75 gals
Total purged volume: 3.9 gal

Collected Sample BSB-GW-06 @ 1020.
1-250ml HNO3 filtered for dissolved metals.
1-500ml RAW for pH, SC, Cl⁻, SO_4^{-2}

Armstrong-Hollomanoff site @ 1200.

FIGURES


5469.98
CLK-2
5473.29
CLK-1
5481.84
BSB-A5
5494.23
BSB-A1
5502.02
BSB-A6R
5514.40
MBMG-2
CLARK TAILINGS
OLD BUTTE LANDFILL
BEEF TRAIL ROAD
EX. FENCE/FLUME
GAS

LEGEND

- ● MONITORING WELL
- — CONTOUR

CONTOUR INTERVAL= 10'

N

DISPLAYED AS:	
COORD SYS/ZONE:	NA
DATUM:	NA
UNITS:	FEET
SOURCE:	PIONEER

SCALE IN FEET
0 300 600

FIGURE 2

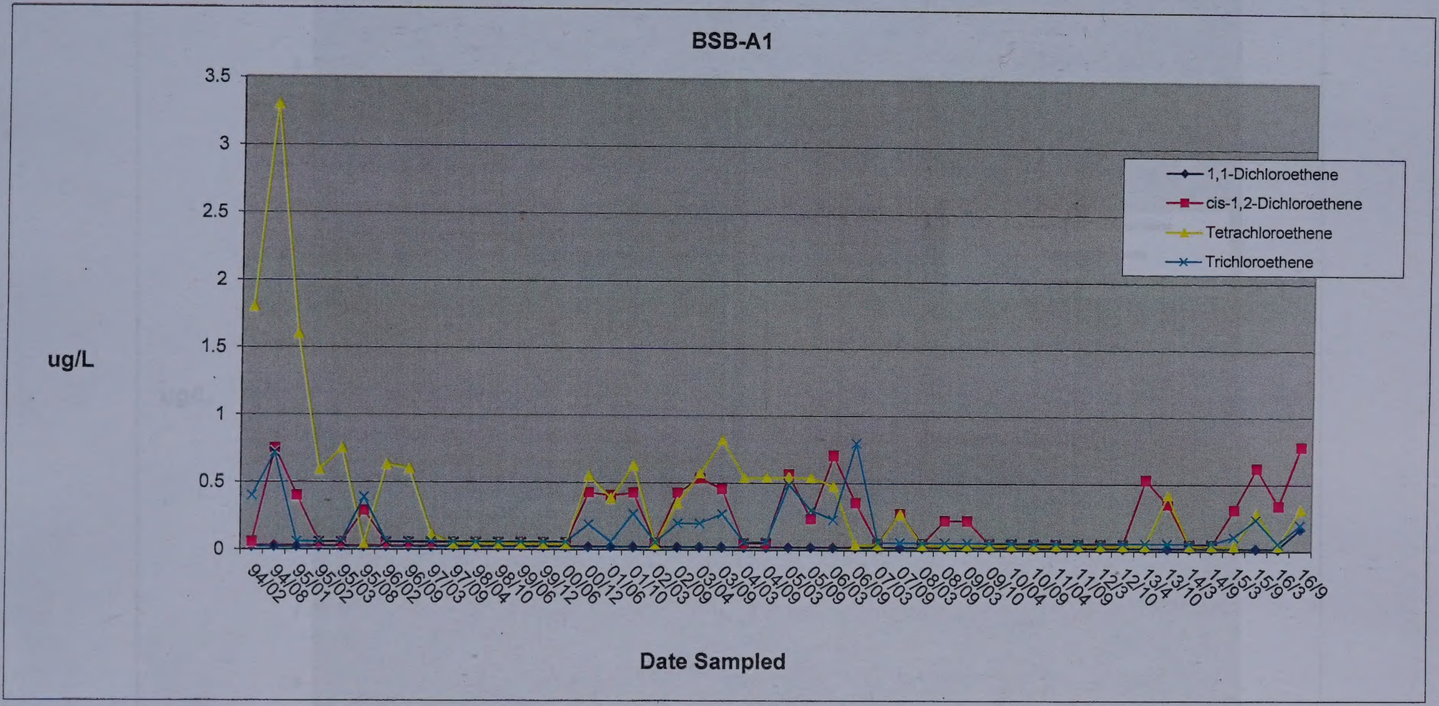
PIONEER
TECHNICAL SERVICES, INC.
1101 SOUTH MONTANA
BUTTE, MONTANA 59701
(406) 782-5177

OLD MUNICIPAL LANDFILL SITE/CLARK TAILINGS FACILITY SEPTEMBER 2016

DATE: 12/12/16

12/13/2016 9:10:43 AM P:\BUTTE-SILVER BOW\2016\SEPT OLD LANDFILL GW MON REPORT\DWG\OLDLNDFL-FG-PLN-001-16.DWG

GRAPHS


BSB-A1
ug/L
3.5
3
2.5
2
1.5
1
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0
94/02
94/08
95/01
95/02
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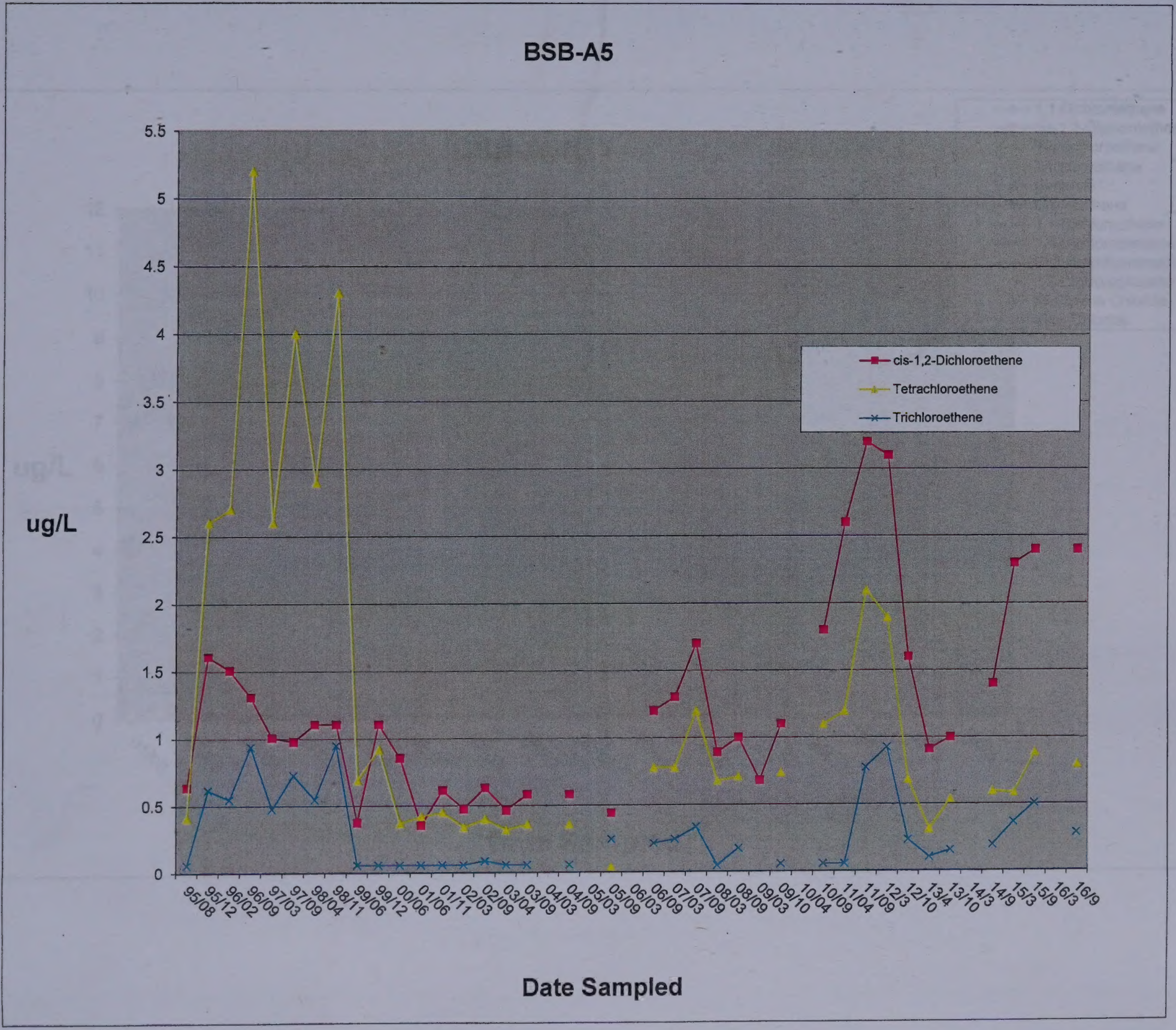
14/3
14/9
15/3
15/9
16/3
16/9
Date Sampled
1,1-Dichloroethene
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene


BSB-A5
ug/L
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
95/08
95/12
96/02
96/09
97/03
97/09
98/04
98/11
99/06
99/12
00/06
01/06
01/11
02/03
02/09
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14/3
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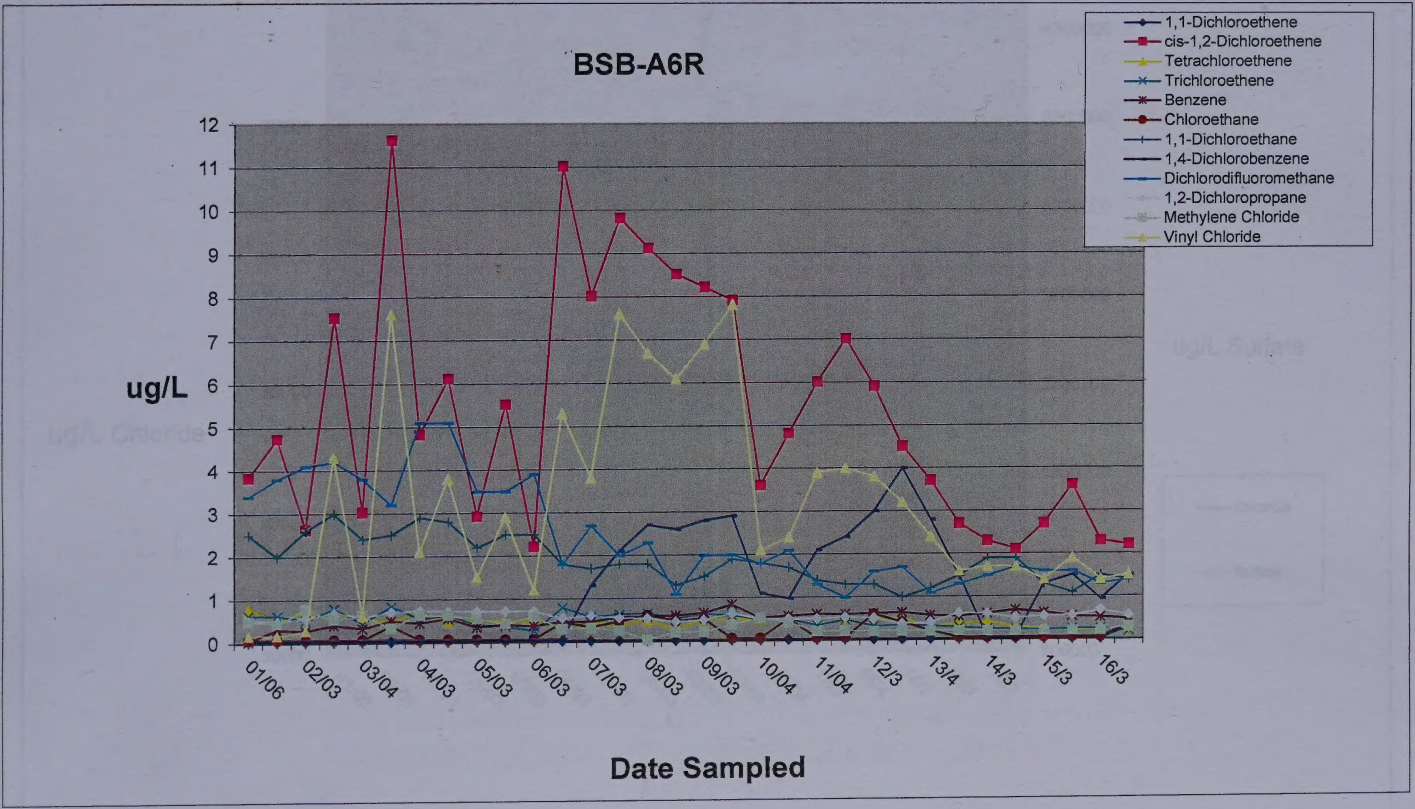
15/9
16/3
16/9
Date Sampled


BSB-A6R
ug/L
0
1
2
3
4
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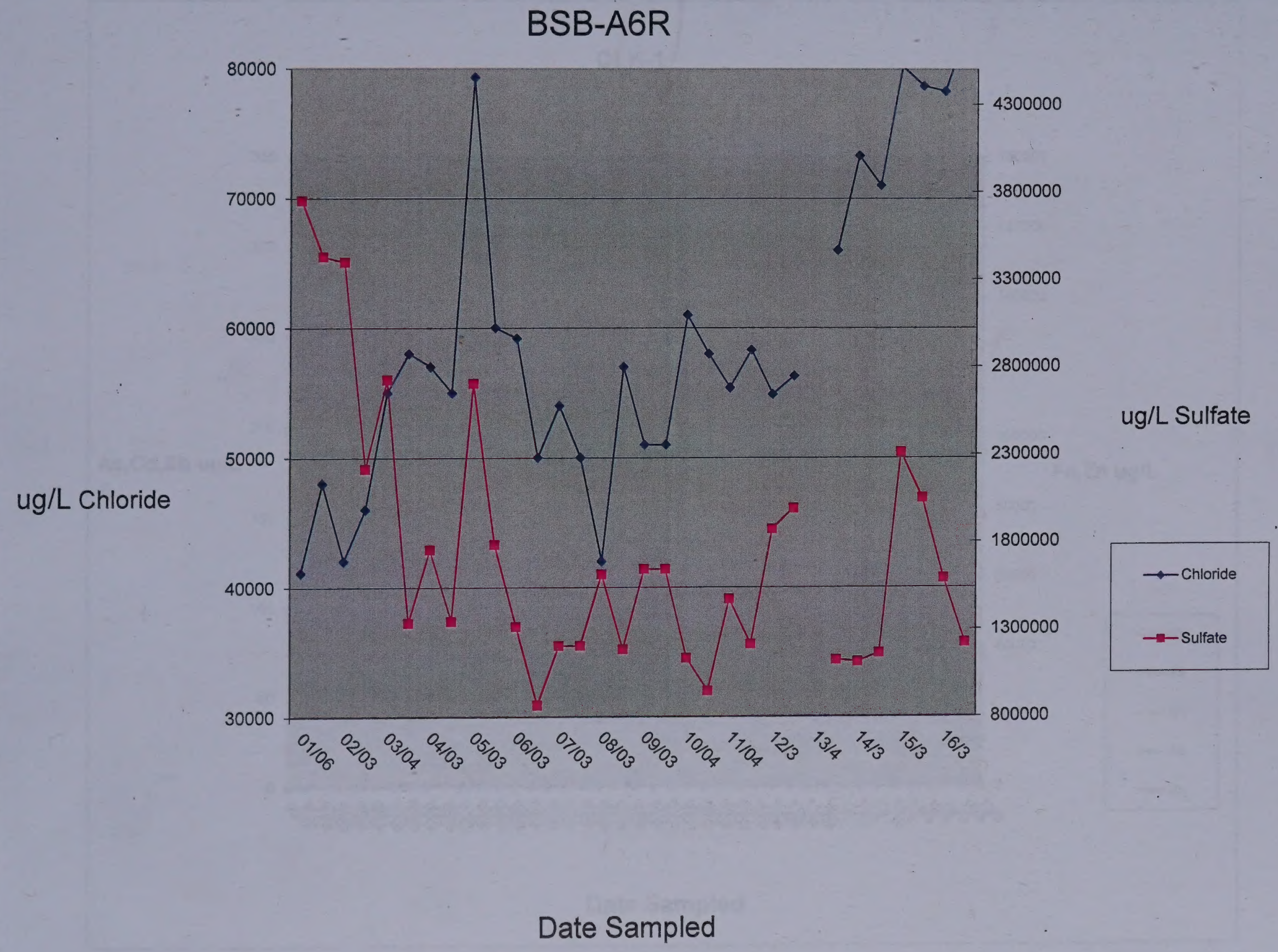
6
7
8
9
10
11
12
01/06
02/03
03/04
04/03
05/03
06/03
07/03
08/03
09/03
10/04
11/04
12/3
13/4
14/3
15/3
16/3
Date Sampled
1,1-Dichloroethene
cis-1,2-Dichloroethene
Tetrachloroethene
Trichloroethene
Benzene
Chloroethane
1,1-Dichloroethane
1,4-Dichlorobenzene
Dichlorodifluoromethane
1,2-Dichloropropane
Methylene Chloride
Vinyl Chloride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ug/L Chloride
80000
70000
60000
50000
40000
30000
ug/L Sulfate
4300000
3800000
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2300000
1800000
1300000
800000
01/06
02/03
03/04
04/03
05/03
06/03
07/03
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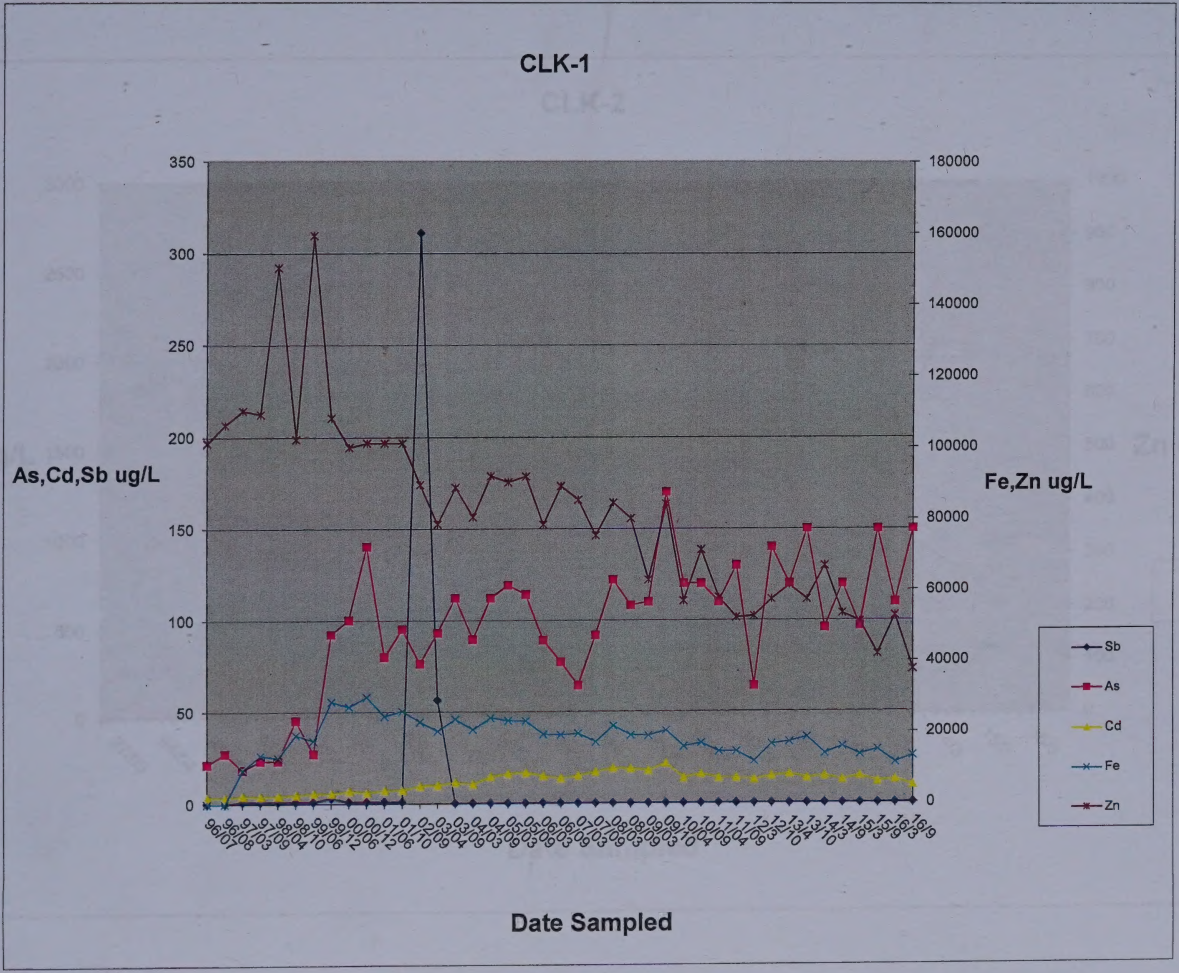
10/04
11/04
12/3
13/4
14/3
15/3
16/3
Date Sampled
Chloride
Sulfate


CLK-1
As,Cd,Sb ug/L
350
300
250
200
150
100
50
0
Fe,Zn ug/L
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
96/07
96/08
97/03
97/09
98/04
98/10
99/06
99/12
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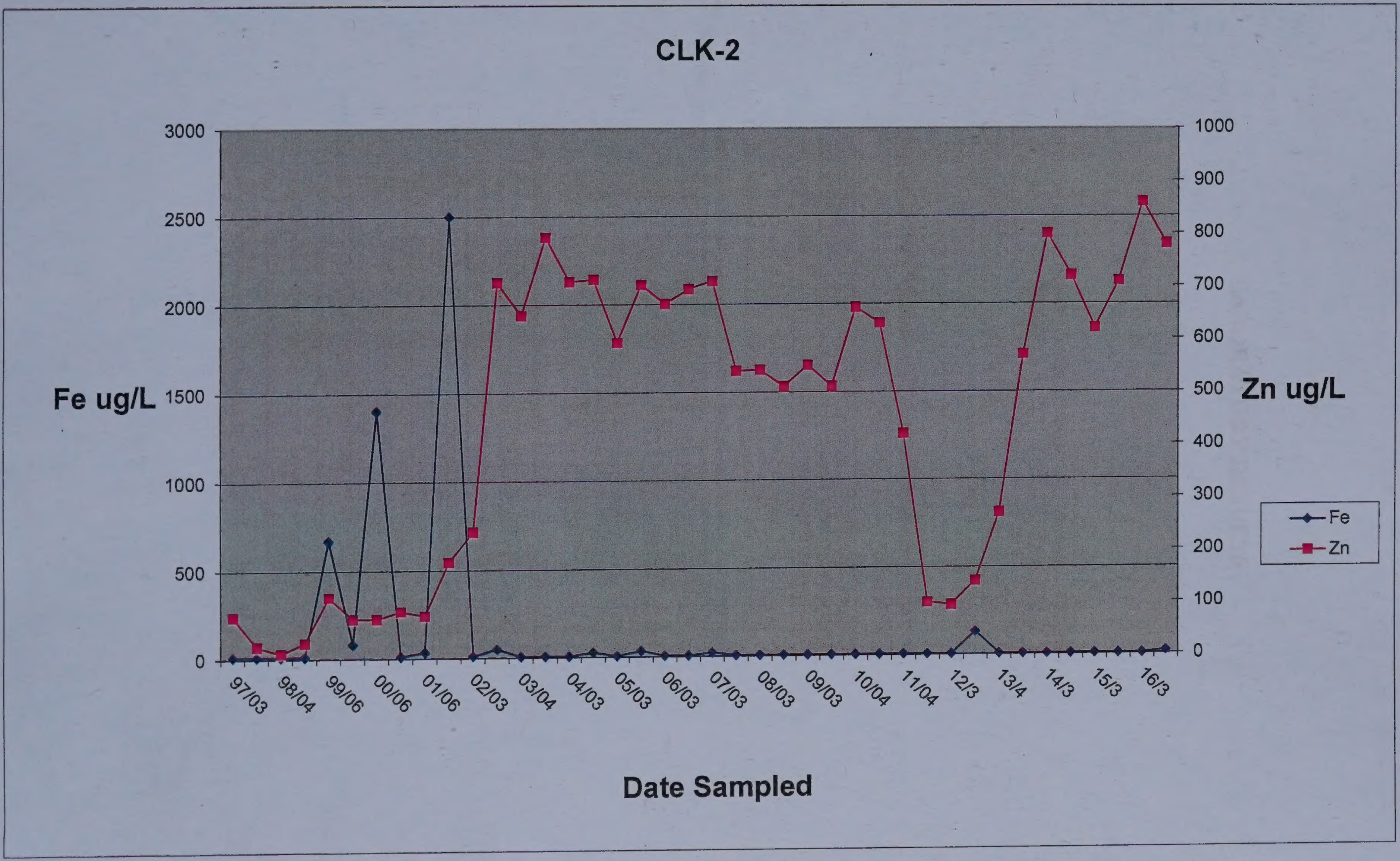
Date Sampled
Sb
As
Cd
Fe
Zn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Fe ug/L
3000
2500
2000
1500
1000
500
0
Zn ug/L
1000
900
800
700
600
500
400
300
200
100
0
97/03
98/04
99/06
00/06
01/06
02/03
03/04
04/03
05/03
06/03
07/03
08/03
09/03
10/04
11/04
12/3
13/4
14/3
15/3
16/3
Date Sampled
Fe
Zn

LABORATORY RESULTS

Pace Analytical®
www.pacelabs.com

Pace Analytical Services, Inc.
1700 Elm Street - Suite 200
Minneapolis, MN 55414
(612)607-1700

September 21, 2016

JD Emmert
Pioneer Technical Services
40 Spanish Peak Drive
Suite 101
Bozeman, MT 59718

RE: Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

Dear JD Emmert:

Enclosed are the analytical results for sample(s) received by the laboratory on September 10, 2016. The results relate only to the samples included in this report. Results reported herein conform to the most current TNI standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Julie Bowser
julie.bowser@pacelabs.com
Project Manager

Enclosures

cc: Mitch Mihailovich, Pioneer Technical Services

CERTIFICATIONS

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

Minnesota Certification IDs

1700 Elm Street SE Suite 200, Minneapolis, MN 55414
525 N 8th Street, Salina, KS 67401
A2LA Certification #: 2926.01
Alaska Certification #: UST-078
Alaska Certification #MN00064
Alabama Certification #40770
Arizona Certification #: AZ-0014
Arkansas Certification #: 88-0680
California Certification #: 01155CA
Colorado Certification #Pace
Connecticut Certification #: PH-0256
EPA Region 8 Certification #: 8TMS-L
Florida/NELAP Certification #: E87605
Guam Certification #:14-008r
Georgia Certification #: 959
Georgia EPD #: Pace
Idaho Certification #: MN00064
Hawaii Certification #MN00064
Illinois Certification #: 200011
Indiana Certification#C-MN-01
Iowa Certification #: 368
Kansas Certification #: E-10167
Kentucky Dept of Envi. Protection - DW #90062
Kentucky Dept of Envi. Protection - WW #:90062
Louisiana DEQ Certification #: 3086
Louisiana DHH #: LA140001
Maine Certification #: 2013011
Maryland Certification #: 322
Michigan DEPH Certification #: 9909
Minnesota Certification #: 027-053-137
Mississippi Certification #: Pace
Montana Certification #: MT0092
Nevada Certification #: MN_00064
Nebraska Certification #: Pace
New Jersey Certification #: MN-002
New York Certification #: 11647
North Carolina Certification #: 530
North Carolina State Public Health #: 27700
North Dakota Certification #: R-036
Ohio EPA #: 4150
Ohio VAP Certification #: CL101
Oklahoma Certification #: 9507
Oregon Certification #: MN200001
Oregon Certification #: MN300001
Pennsylvania Certification #: 68-00563
Puerto Rico Certification
Saipan (CNMI) #:MP0003
South Carolina #:74003001
Texas Certification #: T104704192
Tennessee Certification #: 02818
Utah Certification #: MN000642013-4
Virginia DGS Certification #: 251
Virginia/VELAP Certification #: Pace
Washington Certification #: C486
West Virginia Certification #: 382
West Virginia DHHR #:9952C
Wisconsin Certification #: 999407970

SAMPLE SUMMARY

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

Lab ID	Sample ID	Matrix	Date Collected	Date Received
10361996001	**BSB-GW-06-090816**	Water	09/08/16 10:20	09/10/16 09:45
10361996002	**BSB-GW-05-090816**	Water	09/08/16 11:10	09/10/16 09:45
10361996003	**BSB-GW-08-090816**	Water	09/08/16 11:25	09/10/16 09:45
10361996004	**BSB-GW-09-090816**	Water	09/08/16 11:00	09/10/16 09:45

SAMPLE ANALYTE COUNT

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
10361996001	BSB-GW-06-090816	EPA 200.8	TT3	14	PASI-M
		EPA 120.1	CJM	1	PASI-M
		SM 4500-H+B	CJM	1	PASI-M
		ASTM D516	KEO	1	PASI-M
		SM 4500-Cl E	KEO	1	PASI-M
10361996002	BSB-GW-05-090816	EPA 200.8	TT3	14	PASI-M
		EPA 120.1	CJM	1	PASI-M
		SM 4500-H+B	CJM	1	PASI-M
		ASTM D516	KEO	1	PASI-M
		SM 4500-Cl E	KEO	1	PASI-M
10361996003	BSB-GW-08-090816	EPA 200.8	TT3	14	PASI-M
		EPA 120.1	CJM	1	PASI-M
		SM 4500-H+B	CJM	1	PASI-M
		ASTM D516	KEO	1	PASI-M
		SM 4500-Cl E	KEO	1	PASI-M
10361996004	BSB-GW-09-090816	EPA 200.8	TT3	14	PASI-M
		EPA 120.1	CJM	1	PASI-M
		SM 4500-H+B	CJM	1	PASI-M
		ASTM D516	KEO	1	PASI-M
		SM 4500-Cl E	KEO	1	PASI-M

PROJECT NARRATIVE

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

Method: **EPA 200.8**
Description: 200.8 MET ICPMS, Dissolved
Client: BPAR-PIONEER-MT
Date: September 21, 2016

General Information:
4 samples were analyzed for EPA 200.8. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 200.8 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Internal Standards:
All internal standards were within QC limits with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

QC Batch: 435049

B: Analyte was detected in the associated method blank.
- BLANK for HBN 435049 [MPRP/665 (Lab ID: 2364979)
  - Chromium, Dissolved
  - Vanadium, Dissolved

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 435049

A matrix spike and/or matrix spike duplicate (MS/MSD) were performed on the following sample(s): 10361996001

M1: Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.
- MS (Lab ID: 2364981)
  - Zinc, Dissolved
- MSD (Lab ID: 2364982)
  - Zinc, Dissolved

Additional Comments:

PROJECT NARRATIVE

Project:	Old Landfill/Clark Tailings
Pace Project No.:	10361996

Method:	EPA 200.8
Description:	200.8 MET ICPMS, Dissolved
Client:	BPAR-PIONEER-MT
Date:	September 21, 2016

Analyte Comments:

QC Batch: 435049

E: Analyte concentration exceeded the calibration range. The reported result is estimated.

- MS (Lab ID: 2364981)
  - Zinc, Dissolved
- MSD (Lab ID: 2364982)
  - Zinc, Dissolved

PROJECT NARRATIVE

Project:	Old Landfill/Clark Tailings
Pace Project No.:	10361996

Method: EPA 120.1
Description: 120.1 Specific Conductance
Client: BPAR-PIONEER-MT
Date: September 21, 2016

General Information:
4 samples were analyzed for EPA 120.1. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project:	Old Landfill/Clark Tailings
Pace Project No.:	10361996

Method: **SM 4500-H+B**
Description: 4500H+ pH, Electrometric
Client: BPAR-PIONEER-MT
Date: September 21, 2016

General Information:
4 samples were analyzed for SM 4500-H+B. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

H6: Analysis initiated outside of the 15 minute EPA required holding time.
- BSB-GW-05-090816 (Lab ID: 10361996002)
- BSB-GW-06-090816 (Lab ID: 10361996001)
- BSB-GW-08-090816 (Lab ID: 10361996003)
- BSB-GW-09-090816 (Lab ID: 10361996004)

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

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PROJECT NARRATIVE

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

Method: **ASTM D516**
Description: ASTM D516 Sulfate Water
Client: BPAR-PIONEER-MT
Date: September 21, 2016

General Information:
4 samples were analyzed for ASTM D516. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 436035

A matrix spike and/or matrix spike duplicate (MS/MSD) were performed on the following sample(s): 10361996001,10362230002

M6: Matrix spike and Matrix spike duplicate recovery not evaluated against control limits due to sample dilution.

- MS (Lab ID: 2369460)
  - Sulfate
- MS (Lab ID: 2369462)
  - Sulfate
- MSD (Lab ID: 2369461)
  - Sulfate

Additional Comments:

PROJECT NARRATIVE

Project:	Old Landfill/Clark Tailings
Pace Project No.:	10361996

Method: **SM 4500-Cl E**
Description: SM4500Cl-E Chloride
Client: BPAR-PIONEER-MT
Date: September 21, 2016

General Information:
4 samples were analyzed for SM 4500-Cl E. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

This data package has been reviewed for quality and completeness and is approved for release.

ANALYTICAL RESULTS

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

Sample: BSB-GW-06-090816 **Lab ID: 10361996001** Collected: 09/08/16 10:20 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Zinc, Dissolved	**0.78**	mg/L	0.10	0.016	20	09/16/16 10:36	09/16/16 15:00	7440-66-6	M1
Beryllium, Dissolved	ND	mg/L	0.00020	0.000030	1	09/16/16 10:36	09/19/16 15:18	7440-41-7	
Vanadium, Dissolved	**0.0022**	mg/L	0.0010	0.000085	1	09/16/16 10:36	09/19/16 15:18	7440-62-2	
Chromium, Dissolved	**0.00027J**	mg/L	0.00050	0.00014	1	09/16/16 10:36	09/19/16 15:18	7440-47-3	B
Cobalt, Dissolved	**0.00048J**	mg/L	0.00050	0.000021	1	09/16/16 10:36	09/19/16 15:18	7440-48-4	
Nickel, Dissolved	**0.055**	mg/L	0.00050	0.000099	1	09/16/16 10:36	09/19/16 15:18	7440-02-0	
Copper, Dissolved	**0.0019**	mg/L	0.0010	0.00040	1	09/16/16 10:36	09/19/16 15:18	7440-50-8	
Arsenic, Dissolved	**0.0011**	mg/L	0.00050	0.000091	1	09/16/16 10:36	09/19/16 15:18	7440-38-2	
Selenium, Dissolved	**0.00015J**	mg/L	0.00050	0.00013	1	09/16/16 10:36	09/19/16 15:18	7782-49-2	
Cadmium, Dissolved	**0.0014**	mg/L	0.000080	0.000013	1	09/16/16 10:36	09/19/16 15:18	7440-43-9	
Antimony, Dissolved	**0.00019J**	mg/L	0.00050	0.000032	1	09/16/16 10:36	09/19/16 15:18	7440-36-0	
Barium, Dissolved	**0.017**	mg/L	0.00030	0.000019	1	09/16/16 10:36	09/19/16 15:18	7440-39-3	
Lead, Dissolved	**0.000049J**	mg/L	0.00010	0.000012	1	09/16/16 10:36	09/19/16 15:18	7439-92-1	
Iron, Dissolved	ND	mg/L	0.050	0.018	1	09/16/16 10:36	09/19/16 15:18	7439-89-6	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**1660**	umhos/cm	1.0	1.0	1		09/21/16 16:32		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**6.4**	Std. Units	0.10	0.10	1		09/21/16 15:02		H6
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**700**	mg/L	62.5	26.0	25		09/16/16 12:45	14808-79-8	M6
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	**66.9**	mg/L	5.0	2.2	5		09/15/16 11:19	16887-00-6	

ANALYTICAL RESULTS

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

Sample: BSB-GW-05-090816 **Lab ID: 10361996002** Collected: 09/08/16 11:10 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Beryllium, Dissolved	**0.00037**	mg/L	0.00020	0.000030	1	09/16/16 10:36	09/19/16 15:13	7440-41-7	
Vanadium, Dissolved	**0.00040J**	mg/L	0.0010	0.000085	1	09/16/16 10:36	09/19/16 15:13	7440-62-2	B
Chromium, Dissolved	**0.00025J**	mg/L	0.00050	0.00014	1	09/16/16 10:36	09/19/16 15:13	7440-47-3	B
Cobalt, Dissolved	**0.035**	mg/L	0.00050	0.000021	1	09/16/16 10:36	09/19/16 15:13	7440-48-4	
Nickel, Dissolved	**0.030**	mg/L	0.00050	0.000099	1	09/16/16 10:36	09/19/16 15:13	7440-02-0	
Copper, Dissolved	**0.00081J**	mg/L	0.0010	0.00040	1	09/16/16 10:36	09/19/16 15:13	7440-50-8	
Arsenic, Dissolved	**0.15**	mg/L	0.00050	0.000091	1	09/16/16 10:36	09/19/16 15:13	7440-38-2	
Selenium, Dissolved	**0.00016J**	mg/L	0.00050	0.00013	1	09/16/16 10:36	09/19/16 15:13	7782-49-2	
Cadmium, Dissolved	**0.010**	mg/L	0.000080	0.000013	1	09/16/16 10:36	09/19/16 15:13	7440-43-9	
Antimony, Dissolved	**0.00036J**	mg/L	0.00050	0.000032	1	09/16/16 10:36	09/19/16 15:13	7440-36-0	
Barium, Dissolved	**0.022**	mg/L	0.00030	0.000019	1	09/16/16 10:36	09/19/16 15:13	7440-39-3	
Lead, Dissolved	**0.00012**	mg/L	0.00010	0.000012	1	09/16/16 10:36	09/19/16 15:13	7439-92-1	
Iron, Dissolved	**13.4**	mg/L	0.050	0.018	1	09/16/16 10:36	09/19/16 15:13	7439-89-6	
Zinc, Dissolved	**37.6**	mg/L	0.50	0.078	100	09/16/16 10:36	09/19/16 15:31	7440-66-6	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**1480**	umhos/cm	1.0	1.0	1		09/21/16 16:33		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**6.2**	Std. Units	0.10	0.10	1		09/21/16 15:06		H6
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**623**	mg/L	62.5	26.0	25		09/16/16 12:45	14808-79-8	
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	**33.4**	mg/L	2.0	0.90	2		09/15/16 10:59	16887-00-6	

ANALYTICAL RESULTS

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

Sample: BSB-GW-08-090816 **Lab ID: 10361996003** Collected: 09/08/16 11:25 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Zinc, Dissolved	**38.4**	mg/L	0.50	0.078	100	09/16/16 10:36	09/19/16 17:04	7440-66-6	
Beryllium, Dissolved	**0.00033**	mg/L	0.00020	0.000030	1	09/16/16 10:36	09/19/16 15:15	7440-41-7	
Vanadium, Dissolved	**0.00030J**	mg/L	0.0010	0.000085	1	09/16/16 10:36	09/19/16 15:15	7440-62-2	B
Chromium, Dissolved	ND	mg/L	0.00050	0.00014	1	09/16/16 10:36	09/19/16 15:15	7440-47-3	
Cobalt, Dissolved	**0.035**	mg/L	0.00050	0.000021	1	09/16/16 10:36	09/19/16 15:15	7440-48-4	
Nickel, Dissolved	**0.031**	mg/L	0.00050	0.000099	1	09/16/16 10:36	09/19/16 15:15	7440-02-0	
Copper, Dissolved	**0.00069J**	mg/L	0.0010	0.00040	1	09/16/16 10:36	09/19/16 15:15	7440-50-8	
Arsenic, Dissolved	**0.16**	mg/L	0.00050	0.000091	1	09/16/16 10:36	09/19/16 15:15	7440-38-2	
Selenium, Dissolved	ND	mg/L	0.00050	0.00013	1	09/16/16 10:36	09/19/16 15:15	7782-49-2	
Cadmium, Dissolved	**0.010**	mg/L	0.000080	0.000013	1	09/16/16 10:36	09/19/16 15:15	7440-43-9	
Antimony, Dissolved	**0.00018J**	mg/L	0.00050	0.000032	1	09/16/16 10:36	09/19/16 15:15	7440-36-0	
Barium, Dissolved	**0.022**	mg/L	0.00030	0.000019	1	09/16/16 10:36	09/19/16 15:15	7440-39-3	
Lead, Dissolved	**0.000037J**	mg/L	0.00010	0.000012	1	09/16/16 10:36	09/19/16 15:15	7439-92-1	
Iron, Dissolved	**13.8**	mg/L	0.050	0.018	1	09/16/16 10:36	09/19/16 15:15	7439-89-6	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**1460**	umhos/cm	1.0	1.0	1		09/21/16 16:34		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**6.2**	Std. Units	0.10	0.10	1		09/21/16 15:09		H6
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**618**	mg/L	62.5	26.0	25		09/16/16 12:48	14808-79-8	
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	**33.1**	mg/L	2.0	0.90	2		09/15/16 11:02	16887-00-6	

ANALYTICAL RESULTS

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

Sample: BSB-GW-09-090816 **Lab ID: 10361996004** Collected: 09/08/16 11:00 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
200.8 MET ICPMS, Dissolved	Analytical Method: EPA 200.8 Preparation Method: EPA 200.8								
Beryllium, Dissolved	ND	mg/L	0.00020	0.000030	1	09/16/16 10:36	09/19/16 17:06	7440-41-7	
Vanadium, Dissolved	ND	mg/L	0.0010	0.000085	1	09/16/16 10:36	09/19/16 17:06	7440-62-2	
Chromium, Dissolved	ND	mg/L	0.00050	0.00014	1	09/16/16 10:36	09/19/16 17:06	7440-47-3	
Cobalt, Dissolved	ND	mg/L	0.00050	0.000021	1	09/16/16 10:36	09/19/16 17:06	7440-48-4	
Nickel, Dissolved	ND	mg/L	0.00050	0.000099	1	09/16/16 10:36	09/19/16 17:06	7440-02-0	
Copper, Dissolved	ND	mg/L	0.0010	0.00040	1	09/16/16 10:36	09/19/16 17:06	7440-50-8	
Zinc, Dissolved	**0.0014J**	mg/L	0.0050	0.00078	1	09/16/16 10:36	09/19/16 17:06	7440-66-6	
Arsenic, Dissolved	ND	mg/L	0.00050	0.000091	1	09/16/16 10:36	09/19/16 17:06	7440-38-2	
Selenium, Dissolved	ND	mg/L	0.00050	0.00013	1	09/16/16 10:36	09/19/16 17:06	7782-49-2	
Cadmium, Dissolved	ND	mg/L	0.000080	0.000013	1	09/16/16 10:36	09/19/16 17:06	7440-43-9	
Antimony, Dissolved	ND	mg/L	0.00050	0.000032	1	09/16/16 10:36	09/19/16 17:06	7440-36-0	
Barium, Dissolved	**0.000057J**	mg/L	0.00030	0.000019	1	09/16/16 10:36	09/19/16 17:06	7440-39-3	
Lead, Dissolved	**0.000013J**	mg/L	0.00010	0.000012	1	09/16/16 10:36	09/19/16 17:06	7439-92-1	
Iron, Dissolved	ND	mg/L	0.050	0.018	1	09/16/16 10:36	09/19/16 17:06	7439-89-6	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**1.1**	umhos/cm	1.0	1.0	1		09/21/16 16:35		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**7.7**	Std. Units	0.10	0.10	1		09/21/16 15:10		H6
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**1.3J**	mg/L	2.5	1.0	1		09/19/16 10:53	14808-79-8	
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	ND	mg/L	1.0	0.45	1		09/15/16 10:47	16887-00-6	

QUALITY CONTROL DATA

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

QC Batch: 435049
QC Batch Method: EPA 200.8
Analysis Method: EPA 200.8
Analysis Description: 200.8 MET Dissolved
Associated Lab Samples: 10361996001, 10361996002, 10361996003, 10361996004

METHOD BLANK: 2364979
Matrix: Water
Associated Lab Samples: 10361996001, 10361996002, 10361996003, 10361996004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Antimony, Dissolved	mg/L	ND	0.00050	0.000032	09/19/16 15:08	
Arsenic, Dissolved	mg/L	ND	0.00050	0.000091	09/19/16 15:08	
Barium, Dissolved	mg/L	ND	0.00030	0.000019	09/19/16 15:08	
Beryllium, Dissolved	mg/L	ND	0.00020	0.000030	09/19/16 15:08	
Cadmium, Dissolved	mg/L	ND	0.000080	0.000013	09/19/16 15:08	
Chromium, Dissolved	mg/L	0.00021J	0.00050	0.00014	09/19/16 15:08	
Cobalt, Dissolved	mg/L	ND	0.00050	0.000021	09/19/16 15:08	
Copper, Dissolved	mg/L	ND	0.0010	0.00040	09/19/16 15:08	
Iron, Dissolved	mg/L	0.021J	0.050	0.018	09/19/16 15:08	
Lead, Dissolved	mg/L	ND	0.00010	0.000012	09/19/16 15:08	
Nickel, Dissolved	mg/L	ND	0.00050	0.000099	09/19/16 15:08	
Selenium, Dissolved	mg/L	ND	0.00050	0.00013	09/19/16 15:08	
Vanadium, Dissolved	mg/L	0.00014J	0.0010	0.000085	09/19/16 15:08	
Zinc, Dissolved	mg/L	ND	0.0050	0.00078	09/19/16 15:08	

LABORATORY CONTROL SAMPLE: 2364980

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Antimony, Dissolved	mg/L	.1	0.10	103	85-115	
Arsenic, Dissolved	mg/L	.1	0.095	95	85-115	
Barium, Dissolved	mg/L	.1	0.094	94	85-115	
Beryllium, Dissolved	mg/L	.1	0.095	95	85-115	
Cadmium, Dissolved	mg/L	.1	0.095	95	85-115	
Chromium, Dissolved	mg/L	.1	0.098	98	85-115	
Cobalt, Dissolved	mg/L	.1	0.096	96	85-115	
Copper, Dissolved	mg/L	.1	0.092	92	85-115	
Iron, Dissolved	mg/L	2	1.9	96	85-115	
Lead, Dissolved	mg/L	.1	0.095	95	85-115	
Nickel, Dissolved	mg/L	.1	0.097	97	85-115	
Selenium, Dissolved	mg/L	.1	0.097	97	85-115	
Vanadium, Dissolved	mg/L	.1	0.095	95	85-115	
Zinc, Dissolved	mg/L	.1	0.098	98	85-115	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2364981 2364982

Parameter	Units	10361996001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Antimony, Dissolved	mg/L	0.00019J	.1	.1	0.10	0.10	100	100	70-130	0	20	

QUALITY CONTROL DATA

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2364981 2364982

Parameter	Units	10361996001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic, Dissolved	mg/L	0.0011	.1	.1	0.10	0.10	100	99	70-130	1	20	
Barium, Dissolved	mg/L	0.017	.1	.1	0.12	0.12	99	100	70-130	0	20	
Beryllium, Dissolved	mg/L	ND	.1	.1	0.088	0.087	87	87	70-130	0	20	
Cadmium, Dissolved	mg/L	0.0014	.1	.1	0.098	0.097	97	96	70-130	1	20	
Chromium, Dissolved	mg/L	0.00027J	.1	.1	0.10	0.10	102	102	70-130	0	20	
Cobalt, Dissolved	mg/L	0.00048J	.1	.1	0.097	0.097	97	96	70-130	1	20	
Copper, Dissolved	mg/L	0.0019	.1	.1	0.094	0.094	92	92	70-130	1	20	
Iron, Dissolved	mg/L	ND	2	2	2.0	2.0	98	98	70-130	0	20	
Lead, Dissolved	mg/L	0.000049J	.1	.1	0.095	0.095	95	95	70-130	0	20	
Nickel, Dissolved	mg/L	0.055	.1	.1	0.15	0.15	93	92	70-130	1	20	
Selenium, Dissolved	mg/L	0.00015J	.1	.1	0.10	0.10	101	101	70-130	0	20	
Vanadium, Dissolved	mg/L	0.0022	.1	.1	0.11	0.10	103	102	70-130	1	20	
Zinc, Dissolved	mg/L	0.78	.1	.1	0.82	0.81	38	27	70-130	1	20	E,M1

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

QC Batch: 436499
QC Batch Method: EPA 120.1
Analysis Method: EPA 120.1
Analysis Description: 120.1 Specific Conductance
Associated Lab Samples: 10361996001, 10361996002, 10361996003, 10361996004

METHOD BLANK: 2371911
Matrix: Water
Associated Lab Samples: 10361996001, 10361996002, 10361996003, 10361996004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Specific Conductance	umhos/cm	ND	1.0	1.0	09/21/16 16:10	

LABORATORY CONTROL SAMPLE: 2371912

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Specific Conductance	umhos/cm	1000	934	93	90-110	

SAMPLE DUPLICATE: 2371913

Parameter	Units	10361698003 Result	Dup Result	RPD	Max RPD	Qualifiers
Specific Conductance	umhos/cm	1480	1490	1	20	

SAMPLE DUPLICATE: 2371914

Parameter	Units	10361883005 Result	Dup Result	RPD	Max RPD	Qualifiers
Specific Conductance	umhos/cm	1020	1050	3	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

QC Batch: 436501
Analysis Method: SM 4500-H+B
QC Batch Method: SM 4500-H+B
Analysis Description: 4500H+B pH
Associated Lab Samples: 10361996001, 10361996002, 10361996003, 10361996004

LABORATORY CONTROL SAMPLE: 2371915

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
pH at 25 Degrees C	Std. Units	5	5.0	100	98-102	H6

SAMPLE DUPLICATE: 2371916

Parameter	Units	10361883001 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	6.6	6.7	1	3	H6

SAMPLE DUPLICATE: 2371917

Parameter	Units	10361996002 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	6.2	6.2	0	3	H6

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

QC Batch: 436035
QC Batch Method: ASTM D516
Analysis Method: ASTM D516
Analysis Description: ASTM D516 Sulfate Water
Associated Lab Samples: 10361996001, 10361996002, 10361996003

METHOD BLANK: 2369457 Matrix: Water
Associated Lab Samples: 10361996001, 10361996002, 10361996003

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Sulfate	mg/L	1.1J	2.5	1.0	09/16/16 11:59	

LABORATORY CONTROL SAMPLE & LCSD: 2369458 2369459

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Sulfate	mg/L	7.5	7.8	7.9	104	106	80-120	1	20	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2369460 2369461

Parameter	Units	10361996001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Sulfate	mg/L	700	20	20	712	704	57	20	80-120	1	30	M6

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2369462 2369463

Parameter	Units	10362230002 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Sulfate	mg/L	345	20	20	355	367	49	111	80-120	3	30	M6

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QUALITY CONTROL DATA

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

QC Batch: 436291
QC Batch Method: ASTM D516
Analysis Method: ASTM D516
Analysis Description: ASTM D516 Sulfate Water
Associated Lab Samples: 10361996004

METHOD BLANK: 2371066
Matrix: Water
Associated Lab Samples: 10361996004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Sulfate	mg/L	ND	2.5	1.0	09/19/16 10:53	

LABORATORY CONTROL SAMPLE & LCSD: 2371067 2371068

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Sulfate	mg/L	7.5	8.1	8.1	107	108	80-120	1	20	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2371069 2371070

Parameter	Units	10361996004 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Sulfate	mg/L	1.3J	20	20	22.1	22.1	104	104	80-120	0	30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

QC Batch: 435779
Analysis Method: SM 4500-Cl E
QC Batch Method: SM 4500-Cl E
Analysis Description: SM4500Cl-E Chloride
Associated Lab Samples: 10361996001, 10361996002, 10361996003, 10361996004

METHOD BLANK: 2368321
Matrix: Water
Associated Lab Samples: 10361996001, 10361996002, 10361996003, 10361996004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Chloride	mg/L	ND	1.0	0.45	09/15/16 10:38	FS

LABORATORY CONTROL SAMPLE: 2368322

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Chloride	mg/L	15	15.0	100	90-110	FS

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2368323 2368324

Parameter	Units	10361996001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	66.9	15	15	82.7	83.4	105	110	80-120	1	30	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2368325 2368326

Parameter	Units	10361996002 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	33.4	15	15	46.3	46.8	86	89	80-120	1	30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALIFIERS

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.
ND - Not Detected at or above adjusted reporting limit.
J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
MDL - Adjusted Method Detection Limit.
PQL - Practical Quantitation Limit.
RL - Reporting Limit.
S - Surrogate
1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.
Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.
LCS(D) - Laboratory Control Sample (Duplicate)
MS(D) - Matrix Spike (Duplicate)
DUP - Sample Duplicate
RPD - Relative Percent Difference
NC - Not Calculable.
SG - Silica Gel - Clean-Up
U - Indicates the compound was analyzed for, but not detected.
N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.
Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.
TNI - The NELAC Institute.

LABORATORIES

PASI-M	Pace Analytical Services - Minneapolis

ANALYTE QUALIFIERS

B	Analyte was detected in the associated method blank.
E	Analyte concentration exceeded the calibration range. The reported result is estimated.
FS	The sample was filtered in the laboratory prior to analysis.
H6	Analysis initiated outside of the 15 minute EPA required holding time.
M1	Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.
M6	Matrix spike and Matrix spike duplicate recovery not evaluated against control limits due to sample dilution.

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QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: Old Landfill/Clark Tailings
Pace Project No.: 10361996

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
10361996001	**BSB-GW-06-090816**	EPA 200.8	435049	EPA 200.8	436068
10361996002	**BSB-GW-05-090816**	EPA 200.8	435049	EPA 200.8	436068
10361996003	**BSB-GW-08-090816**	EPA 200.8	435049	EPA 200.8	436068
10361996004	**BSB-GW-09-090816**	EPA 200.8	435049	EPA 200.8	436068
10361996001	**BSB-GW-06-090816**	EPA 120.1	436499		
10361996002	**BSB-GW-05-090816**	EPA 120.1	436499		
10361996003	**BSB-GW-08-090816**	EPA 120.1	436499		
10361996004	**BSB-GW-09-090816**	EPA 120.1	436499		
10361996001	**BSB-GW-06-090816**	SM 4500-H+B	436501		
10361996002	**BSB-GW-05-090816**	SM 4500-H+B	436501		
10361996003	**BSB-GW-08-090816**	SM 4500-H+B	436501		
10361996004	**BSB-GW-09-090816**	SM 4500-H+B	436501		
10361996001	**BSB-GW-06-090816**	ASTM D516	436035		
10361996002	**BSB-GW-05-090816**	ASTM D516	436035		
10361996003	**BSB-GW-08-090816**	ASTM D516	436035		
10361996004	**BSB-GW-09-090816**	ASTM D516	436291		
10361996001	**BSB-GW-06-090816**	SM 4500-Cl E	435779		
10361996002	**BSB-GW-05-090816**	SM 4500-Cl E	435779		
10361996003	**BSB-GW-08-090816**	SM 4500-Cl E	435779		
10361996004	**BSB-GW-09-090816**	SM 4500-Cl E	435779		

bp rm

Laboratory Management Program LaMP Chain of Custody Record

Page 1 of 1

BP Site Node Path:

Req Due Date (mm/dd/yy): 9/26/16 Rush TAT: Yes ___ No X

BP Facility No: Old Landfill/Clark Tailings

Lab Work Order Number:

Lab Name: Pace Analytical	Facility Address:	Consultant/Contractor: Pioneer Technical Services
Lab Address: 1700 Elm Street, Suite 200	City, State, ZIP Code: Butte, MT. 59701	Consultant/Contractor Project No:
Lab PM: Julie Bowser	Lead Regulatory Agency:	Address: 40 Spanish Peak Drive, Suire 101 Bozeman, MT 59718
Lab Phone: 612-437-2613	California Global ID No.:	Consultant/Contractor PM: J.D. Emmert
Lab Shipping Accnt: 1797-5692-7	Enfos Proposal No:	Phone: 406-782-5177 Email: jemmert@pioneer-technical.com
Lab Bottle Order No:	Accounting Mode: Provision ___ OOC-BU ___ OOC-RM ___	Email EDD To: and to lab.enfosdoc@bp.com
Other Info:	Stage: Activity:	Invoice To: BP x Contractor ___
BP Project Manager (PM):		Report Type & QC Level
BP PM Phone:		Standard x
BP PM Email:		Full Data Package ___

Lab No.	Sample Description	Date	Time	Matrix: Soil / Solid	Water / Liquid	Air / Vapor	Is this location a well?	No. Containers / Preservative: Total Number of Container	Unpreserved	H2SO4	HNO3 (filtered)	HCl	Methanol		Requested Analyses: Dissolved Metals (Sb, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Ni, Se, V, Zn)	pH, SC, Chloride, SO4					Comments Note: If sample not collected, indicate "No Sample" in comments and single-strike out and initial any preprinted sample description.
	BSB-GW-06-	9/8/16	1020		x			2	1		1				x	x					
	BSB-GW-05-		1110		x			2	1		1				x	x					
	BSB-GW-08-		1125		x			2	1		1				x	x					
	BSB-GW-09-		11:00		x			2	1		1				x	x					

	Relinquished By / Affiliation	Date	Time	Accepted By / Affiliation	Date	Time
Sampler's Name: Brad Hollamon	Brad Hollam	9/8/16	12:00		9-10-16	9:45
Sampler's Company: Pioneer Technical Services						
Shipment Method: FedEx Ship Date: 9/8/16						
Shipment Tracking No: 6751 5819 2485						

Special Instructions:

THIS LINE - LAB USE ONLY: Custody Seals In Place: [✓ Yes] / No | Temp Blank: [✓ Yes] / No | Cooler Temp on Receipt: 1.5 °F/[✓ C] | Trip Blank: Yes [✓ No] | MS/MSD Sample Submitted: Yes [✓ No]

BP Remediation Management COC - Effective Dates: August 23, 2011- June 30, 2012

BP LaMP COC Rev. 7, Aug 23, 2011

Pace Analytical	Document Name: **Sample Condition Upon Receipt Form - ESI**	Document Revised: 04APR2016 Page 1 of 2
	Document No.: **F-MN-L-210-rev.20**	Issuing Authority: Pace Minnesota Quality Office

Sample Condition Upon Receipt – ESI Tech Specs

Client Name: BP - Pioneer Tech

Project #: WO#: 10361996

10361996

Courier: ☑ Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☐ Pace ☐ SpeeDee ☐ Other:

Tracking Number: 6751 5819 2485

Custody Seal on Cooler/Box Present? ☑ Yes ☐ No **Seals Intact?** ☑ Yes ☐ No

Optional: **Proj. Due Date:** **Proj. Name:**

Packing Material: ☑ Bubble Wrap ☐ Bubble Bags ☐ None ☐ Other:

Temp Blank? ☑ Yes ☐ No

Thermometer Used: ☑ 151401163 ☐ 151401164 ☐ B88A912167504 ☐ B88A0143310098

Type of Ice: ☑ Wet ☐ Blue ☐ None ☐ Samples on ice, cooling process has begun

Cooler Temp Read (°C): 16 **Cooler Temp Corrected (°C):** 1.5 **Biological Tissue Frozen?** ☐ Yes ☐ No ☑ NA

Temp should be above freezing to 6°C **Correction Factor:** -0.1 **Date and Initials of Person Examining Contents:** KAC 9-10-16

USDA Regulated Soil (☑ N/A, water sample)

Did samples originate in a quarantine zone within the United States: AL, AR, AZ, CA, FL, GA, ID, LA. MS, NC, NM, NY, OK, OR, SC, TN, TX or VA (check maps)? ☐ Yes ☐ No

Did samples originate from a foreign source (internationally, including Hawaii and Puerto Rico)? ☐ Yes ☐ No

If Yes to either question, fill out a Regulated Soil Checklist (F-MN-Q-338) and include with SCUR/COC paperwork.

				COMMENTS:
Chain of Custody Present?	☑ Yes	☐ No	☐ N/A	1.
Chain of Custody Filled Out?	☑ Yes	☐ No	☐ N/A	2.
Chain of Custody Relinquished?	☑ Yes	☐ No	☐ N/A	3.
Sampler Name and/or Signature on COC?	☑ Yes	☐ No	☐ N/A	4.
Samples Arrived within Hold Time?	☑ Yes	☐ No	☐ N/A	5.
Short Hold Time Analysis (<72 hr)?	☐ Yes	☑ No	☐ N/A	6.
Rush Turn Around Time Requested?	☐ Yes	☑ No	☐ N/A	7.
Sufficient Volume (triple volume provided for MS/MSD)?	☐ Yes	☐ No	☑ N/A	8.
Correct Containers Used?	☑ Yes	☐ No	☐ N/A	9.
-Pace Containers Used?	☑ Yes	☐ No	☐ N/A	
Containers Intact?	☑ Yes	☐ No	☐ N/A	10.
Filtered Volume Received for Dissolved Tests? KAC 9-10-16	☑ Yes	☐ No	☒ N/A	11. Note if sediment is visible in the dissolved container.
Sample Labels Match COC? -Includes Date/Time/ID/Analysis Matrix: WT	☑ Yes	☐ No	☐ N/A	12.
All containers needing acid/base preservation have been checked?	☑ Yes	☐ No	☐ N/A	13. ☑ HNO_3 ☐ H_2SO_4 ☐ NaOH ☐ HCl
All containers needing preservation are found to be in compliance with EPA recommendation? (HNO_3, H_2SO_4, HCl<2; NaOH>9 Sulfide, NaOH>12 Cyanide)	☑ Yes	☐ No	☐ N/A	Sample # 1-4: T
Exceptions: VOA, Coliform, TOC, Oil and Grease, DRO/8015 (water) DOC Per method, VOA pH is checked after analysis	☐ Yes	☐ No	☑ N/A	Initial when completed: Lot # of added preservative:
Headspace in VOA Vials (>6mm)?	☐ Yes	☐ No	☑ N/A	14.
3 Trip Blanks Present?	☐ Yes	☐ No	☑ N/A	15.
Trip Blank Custody Seals Present?	☐ Yes	☐ No	☑ N/A	
Pace Trip Blank Lot # (if purchased):				

CLIENT NOTIFICATION/RESOLUTION

Field Data Required? ☐ Yes ☐ No

Person Contacted: Date/Time:

Comments/Resolution:

verfied with Brad that sample ID's should have date of collection at the end

Temp Log: Temp must be maintained at <6°C during login, record temp every 20 mins		
Opened Time: 16:04 Temp: 1.6	Corrected Temp: 1.5	
Time: 16:14 put in cooler		
Time: Temp:	Corrected Temp:	

Project Manager Review: **Date:** 9/12/16

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers)

Pace Analytical®
www.pacelabs.com

Pace Analytical Services, Inc.
1700 Elm Street - Suite 200
Minneapolis, MN 55414
(612)607-1700

September 23, 2016

Brad Hollamon
Pioneer Technical Services
1101 S. Montana Street
Butte, MT 59701

RE: Project: OLD LANDFILL
Pace Project No.: 10361997

Dear Brad Hollamon:

Enclosed are the analytical results for sample(s) received by the laboratory on September 10, 2016. The results relate only to the samples included in this report. Results reported herein conform to the most current TNI standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Julie Bowser
julie.bowser@pacelabs.com
Project Manager

Enclosures

cc: Julie Flammang, Pioneer Technical
Mitch Mihailovich, Pioneer Technical Services

CERTIFICATIONS

Project: OLD LANDFILL
Pace Project No.: 10361997

Minnesota Certification IDs

1700 Elm Street SE Suite 200, Minneapolis, MN 55414
525 N 8th Street, Salina, KS 67401
A2LA Certification #: 2926.01
Alaska Certification #: UST-078
Alaska Certification #MN00064
Alabama Certification #40770
Arizona Certification #: AZ-0014
Arkansas Certification #: 88-0680
California Certification #: 01155CA
Colorado Certification #Pace
Connecticut Certification #: PH-0256
EPA Region 8 Certification #: 8TMS-L
Florida/NELAP Certification #: E87605
Guam Certification #:14-008r
Georgia Certification #: 959
Georgia EPD #: Pace
Idaho Certification #: MN00064
Hawaii Certification #MN00064
Illinois Certification #: 200011
Indiana Certification#C-MN-01
Iowa Certification #: 368
Kansas Certification #: E-10167
Kentucky Dept of Envi. Protection - DW #90062
Kentucky Dept of Envi. Protection - WW #:90062
Louisiana DEQ Certification #: 3086
Louisiana DHH #: LA140001
Maine Certification #: 2013011
Maryland Certification #: 322
Michigan DEPH Certification #: 9909
Minnesota Certification #: 027-053-137
Mississippi Certification #: Pace
Montana Certification #: MT0092
Nevada Certification #: MN_00064
Nebraska Certification #: Pace
New Jersey Certification #: MN-002
New York Certification #: 11647
North Carolina Certification #: 530
North Carolina State Public Health #: 27700
North Dakota Certification #: R-036
Ohio EPA #: 4150
Ohio VAP Certification #: CL101
Oklahoma Certification #: 9507
Oregon Certification #: MN200001
Oregon Certification #: MN300001
Pennsylvania Certification #: 68-00563
Puerto Rico Certification
Saipan (CNMI) #:MP0003
South Carolina #:74003001
Texas Certification #: T104704192
Tennessee Certification #: 02818
Utah Certification #: MN000642013-4
Virginia DGS Certification #: 251
Virginia/VELAP Certification #: Pace
Washington Certification #: C486
West Virginia Certification #: 382
West Virginia DHHR #:9952C
Wisconsin Certification #: 999407970

SAMPLE SUMMARY

Project: OLD LANDFILL
Pace Project No.: 10361997

Lab ID	Sample ID	Matrix	Date Collected	Date Received
10361997001	**BSB-GW-01-090716**	Water	09/07/16 10:37	09/10/16 09:45
10361997002	**BSB-GW-02-090716**	Water	09/07/16 12:23	09/10/16 09:45
10361997003	**BSB-GW-03-090716**	Water	09/07/16 12:55	09/10/16 09:45
10361997004	**BSB-GW-04-090716**	Water	09/07/16 14:25	09/10/16 09:45
10361997005	**BSB-GW-07-090716**	Water	09/07/16 14:40	09/10/16 09:45
10361997006	**Trip Blank**	Water	09/07/16 00:00	09/10/16 09:45

SAMPLE ANALYTE COUNT

Project: OLD LANDFILL
Pace Project No.: 10361997

Lab ID	Sample ID	Method	Analysts	Analytes Reported	Laboratory
10361997001	**BSB-GW-01-090716**	EPA 6020A	RJS	14	PASI-M
		EPA 8260B	DJB	53	PASI-M
		EPA 120.1	PH1	1	PASI-M
		SM 4500-H+B	CJM	1	PASI-M
		EPA 410.4	DCL	1	PASI-M
		SM 4500-NO3 H	DCL	2	PASI-M
		ASTM D516	KEO	1	PASI-M
		SM 4500-Cl E	KEO	1	PASI-M
		SM 4500-CN-E	DCL	1	PASI-M
10361997002	**BSB-GW-02-090716**	EPA 8260B	DJB	53	PASI-M
		EPA 120.1	PH1	1	PASI-M
		SM 4500-H+B	CJM	1	PASI-M
		EPA 410.4	DCL	1	PASI-M
		SM 4500-NO3 H	DCL	2	PASI-M
		ASTM D516	KEO	1	PASI-M
		SM 4500-Cl E	KEO	1	PASI-M
		SM 4500-CN-E	DCL	1	PASI-M
10361997003	**BSB-GW-03-090716**	EPA 8260B	DJB	53	PASI-M
		EPA 120.1	PH1	1	PASI-M
		SM 4500-H+B	CJM	1	PASI-M
		EPA 410.4	DCL	1	PASI-M
		SM 4500-NO3 H	DCL	2	PASI-M
		ASTM D516	KEO	1	PASI-M
		SM 4500-Cl E	KEO	1	PASI-M
		SM 4500-CN-E	DCL	1	PASI-M
10361997004	**BSB-GW-04-090716**	EPA 8260B	DJB	53	PASI-M
		EPA 120.1	PH1	1	PASI-M
		SM 4500-H+B	CJM	1	PASI-M
		EPA 410.4	DCL	1	PASI-M
		SM 4500-NO3 H	DCL	2	PASI-M
		ASTM D516	KEO	1	PASI-M
		SM 4500-Cl E	KEO	1	PASI-M
		SM 4500-CN-E	DCL	1	PASI-M
10361997005	**BSB-GW-07-090716**	EPA 8260B	DJB	53	PASI-M
10361997006	**Trip Blank**	EPA 8260B	DJB	53	PASI-M

PROJECT NARRATIVE

Project:	OLD LANDFILL
Pace Project No.:	10361997

Method: **EPA 6020A**
Description: 6020A MET ICPMS, Dissolved
Client: Pioneer Technical
Date: September 23, 2016

General Information:
1 sample was analyzed for EPA 6020A. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 3020 with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

Internal Standards:
All internal standards were within QC limits with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

QC Batch: 436255

B: Analyte was detected in the associated method blank.

- BLANK for HBN 436255 [MPRP/667 (Lab ID: 2370974)
    - Nickel, Dissolved
    - Zinc, Dissolved

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

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PROJECT NARRATIVE

Project:	OLD LANDFILL
Pace Project No.:	10361997

Method: **EPA 8260B**
Description: 8260B MSV
Client: Pioneer Technical
Date: September 23, 2016

General Information:
6 samples were analyzed for EPA 8260B. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Initial Calibrations (including MS Tune as applicable):
All criteria were within method requirements with any exceptions noted below.

Continuing Calibration:
All criteria were within method requirements with any exceptions noted below.

QC Batch: 436367

CH: The continuing calibration for this compound is outside of Pace Analytical acceptance limits. The results may be biased high.

- BSB-GW-02-090716 (Lab ID: 10361997002)
  - trans-1,4-Dichloro-2-butene
- LCS (Lab ID: 2371484)
  - trans-1,4-Dichloro-2-butene
- LCSD (Lab ID: 2371485)
  - trans-1,4-Dichloro-2-butene
- MS (Lab ID: 2371588)
  - trans-1,4-Dichloro-2-butene

Internal Standards:
All internal standards were within QC limits with any exceptions noted below.

Surrogates:
All surrogates were within QC limits with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

QC Batch: 436367

L0: Analyte recovery in the laboratory control sample (LCS) was outside QC limits.

- LCS (Lab ID: 2371484)
  - trans-1,4-Dichloro-2-butene
- LCSD (Lab ID: 2371485)
  - trans-1,4-Dichloro-2-butene

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

PROJECT NARRATIVE

Project:	OLD LANDFILL
Pace Project No.:	10361997

Method: **EPA 8260B**
Description: 8260B MSV
Client: Pioneer Technical
Date: September 23, 2016

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project: OLD LANDFILL
Pace Project No.: 10361997

Method: **EPA 120.1**
Description: 120.1 Specific Conductance
Client: Pioneer Technical
Date: September 23, 2016

General Information:
4 samples were analyzed for EPA 120.1. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project: OLD LANDFILL
Pace Project No.: 10361997

Method: **SM 4500-H+B**
Description: 4500H+ pH, Electrometric
Client: Pioneer Technical
Date: September 23, 2016

General Information:
4 samples were analyzed for SM 4500-H+B. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

H6: Analysis initiated outside of the 15 minute EPA required holding time.
- BSB-GW-01-090716 (Lab ID: 10361997001)
- BSB-GW-02-090716 (Lab ID: 10361997002)
- BSB-GW-03-090716 (Lab ID: 10361997003)
- BSB-GW-04-090716 (Lab ID: 10361997004)

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Duplicate Sample:
All duplicate sample results were within method acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project: OLD LANDFILL
Pace Project No.: 10361997

Method: EPA 410.4
Description: 410.4 COD
Client: Pioneer Technical
Date: September 23, 2016

General Information:
4 samples were analyzed for EPA 410.4. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with EPA 410.4 with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project: OLD LANDFILL
Pace Project No.: 10361997

Method: **SM 4500-NO3 H**
Description: SM4500NO3-H, NO2 + NO3 pres.
Client: Pioneer Technical
Date: September 23, 2016

General Information:
4 samples were analyzed for SM 4500-NO3 H. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 436463

A matrix spike and/or matrix spike duplicate (MS/MSD) were performed on the following sample(s): 10362345004,10362345005

M1: Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.

- MS (Lab ID: 2371797)
    - Nitrogen, NO2 plus NO3
- MSD (Lab ID: 2371796)
    - Nitrogen, NO2 plus NO3

Additional Comments:

PROJECT NARRATIVE

Project: OLD LANDFILL
Pace Project No.: 10361997

Method: **ASTM D516**
Description: ASTM D516 Sulfate Water
Client: Pioneer Technical
Date: September 23, 2016

General Information:
4 samples were analyzed for ASTM D516. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

QC Batch: 436013

A matrix spike and/or matrix spike duplicate (MS/MSD) were performed on the following sample(s): 10361997001,10362320001

M6: Matrix spike and Matrix spike duplicate recovery not evaluated against control limits due to sample dilution.

- MSD (Lab ID: 2369396)
  - Sulfate

Additional Comments:

PROJECT NARRATIVE

Project:	OLD LANDFILL
Pace Project No.:	10361997

Method: **SM 4500-Cl E**
Description: SM4500Cl-E Chloride
Client: Pioneer Technical
Date: September 23, 2016

General Information:
4 samples were analyzed for SM 4500-Cl E. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

PROJECT NARRATIVE

Project:	OLD LANDFILL
Pace Project No.:	10361997

Method:	**SM 4500-CN-E**
Description:	SM4500CN-E Cyanide
Client:	Pioneer Technical
Date:	September 23, 2016

General Information:
4 samples were analyzed for SM 4500-CN-E. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Sample Preparation:
The samples were prepared in accordance with SM 4500-CN-E with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

This data package has been reviewed for quality and completeness and is approved for release.

ANALYTICAL RESULTS

Project: OLD LANDFILL
Pace Project No.: 10361997

Sample: BSB-GW-01-090716 **Lab ID: 10361997001** Collected: 09/07/16 10:37 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
6020A MET ICPMS, Dissolved	Analytical Method: EPA 6020A Preparation Method: EPA 3020								
Antimony, Dissolved	**0.00026J**	mg/L	0.00050	0.000032	1	09/20/16 10:00	09/20/16 14:37	7440-36-0	
Arsenic, Dissolved	**0.0012**	mg/L	0.00050	0.000091	1	09/20/16 10:00	09/20/16 14:37	7440-38-2	
Barium, Dissolved	**0.16**	mg/L	0.00030	0.000019	1	09/20/16 10:00	09/20/16 14:37	7440-39-3	
Beryllium, Dissolved	ND	mg/L	0.00020	0.000030	1	09/20/16 10:00	09/20/16 14:37	7440-41-7	
Cadmium, Dissolved	**0.000020J**	mg/L	0.000080	0.000013	1	09/20/16 10:00	09/20/16 14:37	7440-43-9	
Chromium, Dissolved	**0.00028J**	mg/L	0.00050	0.00014	1	09/20/16 10:00	09/20/16 14:37	7440-47-3	
Cobalt, Dissolved	**0.00028J**	mg/L	0.00050	0.000021	1	09/20/16 10:00	09/20/16 14:37	7440-48-4	
Copper, Dissolved	**0.0012**	mg/L	0.0010	0.00040	1	09/20/16 10:00	09/20/16 14:37	7440-50-8	
Iron, Dissolved	ND	mg/L	0.050	0.018	1	09/20/16 10:00	09/20/16 14:37	7439-89-6	
Lead, Dissolved	ND	mg/L	0.00010	0.000012	1	09/20/16 10:00	09/20/16 14:37	7439-92-1	
Nickel, Dissolved	**0.00018J**	mg/L	0.00050	0.000099	1	09/20/16 10:00	09/20/16 14:37	7440-02-0	B
Selenium, Dissolved	**0.00072**	mg/L	0.00050	0.00013	1	09/20/16 10:00	09/20/16 14:37	7782-49-2	
Vanadium, Dissolved	**0.0062**	mg/L	0.0010	0.000085	1	09/20/16 10:00	09/20/16 14:37	7440-62-2	
Zinc, Dissolved	**0.0043J**	mg/L	0.0050	0.00078	1	09/20/16 10:00	09/20/16 14:37	7440-66-6	B
8260B MSV	Analytical Method: EPA 8260B								
Acetone	ND	ug/L	20.0	2.0	1		09/20/16 04:38	67-64-1	
Acrylonitrile	ND	ug/L	10.0	0.49	1		09/20/16 04:38	107-13-1	
Benzene	ND	ug/L	1.0	0.16	1		09/20/16 04:38	71-43-2	
Bromochloromethane	ND	ug/L	1.0	0.19	1		09/20/16 04:38	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.24	1		09/20/16 04:38	75-27-4	
Bromoform	ND	ug/L	4.0	0.27	1		09/20/16 04:38	75-25-2	
Bromomethane	ND	ug/L	4.0	0.44	1		09/20/16 04:38	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		09/20/16 04:38	78-93-3	
Carbon disulfide	ND	ug/L	1.0	0.30	1		09/20/16 04:38	75-15-0	
Carbon tetrachloride	ND	ug/L	4.0	0.20	1		09/20/16 04:38	56-23-5	
Chlorobenzene	ND	ug/L	1.0	0.11	1		09/20/16 04:38	108-90-7	
Chloroethane	ND	ug/L	1.0	0.34	1		09/20/16 04:38	75-00-3	
Chloroform	**0.23J**	ug/L	1.0	0.21	1		09/20/16 04:38	67-66-3	
Chloromethane	ND	ug/L	4.0	0.25	1		09/20/16 04:38	74-87-3	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		09/20/16 04:38	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	0.16	1		09/20/16 04:38	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.20	1		09/20/16 04:38	106-93-4	
Dibromomethane	ND	ug/L	4.0	0.19	1		09/20/16 04:38	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	1.0	0.17	1		09/20/16 04:38	95-50-1	
1,4-Dichlorobenzene	ND	ug/L	1.0	0.21	1		09/20/16 04:38	106-46-7	
trans-1,4-Dichloro-2-butene	ND	ug/L	10.0	0.45	1		09/20/16 04:38	110-57-6	L3
Dichlorodifluoromethane	ND	ug/L	1.0	0.23	1		09/20/16 04:38	75-71-8	
1,1-Dichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 04:38	75-34-3	
1,2-Dichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 04:38	107-06-2	
1,1-Dichloroethene	ND	ug/L	1.0	0.28	1		09/20/16 04:38	75-35-4	
cis-1,2-Dichloroethene	ND	ug/L	1.0	0.12	1		09/20/16 04:38	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	1.0	0.16	1		09/20/16 04:38	156-60-5	
1,2-Dichloropropane	ND	ug/L	4.0	0.22	1		09/20/16 04:38	78-87-5	
cis-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		09/20/16 04:38	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		09/20/16 04:38	10061-02-6	

ANALYTICAL RESULTS

Project: OLD LANDFILL
Pace Project No.: 10361997

Sample: BSB-GW-01-090716 **Lab ID: 10361997001** Collected: 09/07/16 10:37 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Ethylbenzene	ND	ug/L	1.0	0.15	1		09/20/16 04:38	100-41-4	
2-Hexanone	ND	ug/L	5.0	0.19	1		09/20/16 04:38	591-78-6	
Iodomethane	ND	ug/L	4.0	0.18	1		09/20/16 04:38	74-88-4	
Methylene Chloride	ND	ug/L	4.0	0.29	1		09/20/16 04:38	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.43	1		09/20/16 04:38	108-10-1	
Styrene	ND	ug/L	1.0	0.29	1		09/20/16 04:38	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	4.0	0.17	1		09/20/16 04:38	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0	0.22	1		09/20/16 04:38	79-34-5	
Tetrachloroethene	ND	ug/L	1.0	0.25	1		09/20/16 04:38	127-18-4	
Toluene	ND	ug/L	1.0	0.14	1		09/20/16 04:38	108-88-3	
1,1,1-Trichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 04:38	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	1.0	0.15	1		09/20/16 04:38	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.20	1		09/20/16 04:38	79-01-6	
Trichlorofluoromethane	ND	ug/L	1.0	0.33	1		09/20/16 04:38	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.28	1		09/20/16 04:38	96-18-4	
Vinyl acetate	ND	ug/L	10.0	0.12	1		09/20/16 04:38	108-05-4	
Vinyl chloride	ND	ug/L	0.40	0.15	1		09/20/16 04:38	75-01-4	
Xylene (Total)	ND	ug/L	3.0	0.32	1		09/20/16 04:38	1330-20-7	
m&p-Xylene	ND	ug/L	2.0	0.11	1		09/20/16 04:38	179601-23-1	
o-Xylene	ND	ug/L	1.0	0.20	1		09/20/16 04:38	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	111	%.	75-125		1		09/20/16 04:38	17060-07-0	
Toluene-d8 (S)	101	%.	75-125		1		09/20/16 04:38	2037-26-5	
4-Bromofluorobenzene (S)	94	%.	75-125		1		09/20/16 04:38	460-00-4	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**896**	umhos/cm	1.0	1.0	1		09/23/16 15:15		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**6.7**	Std. Units	0.10	0.10	1		09/14/16 13:19		H6
410.4 COD	Analytical Method: EPA 410.4 Preparation Method: EPA 410.4								
Chemical Oxygen Demand	**12.5J**	mg/L	50.0	5.4	1	09/15/16 11:47	09/15/16 15:02		
SM4500NO3-H, NO2 + NO3 pres.	Analytical Method: SM 4500-NO3 H								
Nitrate as N	**2.4**	mg/L	0.10	0.018	1		09/20/16 13:42	14797-55-8	
Nitrogen, NO2 plus NO3	**2.4**	mg/L	0.10	0.050	1		09/20/16 13:42		
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**184**	mg/L	25.0	10.4	10		09/16/16 11:39	14808-79-8	M6
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	**79.7**	mg/L	5.0	2.2	5		09/15/16 11:19	16887-00-6	

ANALYTICAL RESULTS

Project: OLD LANDFILL
Pace Project No.: 10361997

Sample: BSB-GW-01-090716 **Lab ID: 10361997001** Collected: 09/07/16 10:37 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
SM4500CN-E Cyanide	Analytical Method: SM 4500-CN-E Preparation Method: SM 4500-CN-E								
Cyanide	ND	ug/L	10.0	4.2	1	09/21/16 10:40	09/21/16 16:21	57-12-5	

ANALYTICAL RESULTS

Project: OLD LANDFILL
Pace Project No.: 10361997

Sample: BSB-GW-02-090716 **Lab ID: 10361997002** Collected: 09/07/16 12:23 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Acetone	ND	ug/L	20.0	2.0	1		09/20/16 04:16	67-64-1	
Acrylonitrile	ND	ug/L	10.0	0.49	1		09/20/16 04:16	107-13-1	
Benzene	ND	ug/L	1.0	0.16	1		09/20/16 04:16	71-43-2	
Bromochloromethane	ND	ug/L	1.0	0.19	1		09/20/16 04:16	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.24	1		09/20/16 04:16	75-27-4	
Bromoform	ND	ug/L	4.0	0.27	1		09/20/16 04:16	75-25-2	
Bromomethane	ND	ug/L	4.0	0.44	1		09/20/16 04:16	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		09/20/16 04:16	78-93-3	
Carbon disulfide	ND	ug/L	1.0	0.30	1		09/20/16 04:16	75-15-0	
Carbon tetrachloride	ND	ug/L	4.0	0.20	1		09/20/16 04:16	56-23-5	
Chlorobenzene	ND	ug/L	1.0	0.11	1		09/20/16 04:16	108-90-7	
Chloroethane	ND	ug/L	1.0	0.34	1		09/20/16 04:16	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		09/20/16 04:16	67-66-3	
Chloromethane	ND	ug/L	4.0	0.25	1		09/20/16 04:16	74-87-3	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		09/20/16 04:16	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	0.16	1		09/20/16 04:16	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.20	1		09/20/16 04:16	106-93-4	
Dibromomethane	ND	ug/L	4.0	0.19	1		09/20/16 04:16	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	1.0	0.17	1		09/20/16 04:16	95-50-1	
1,4-Dichlorobenzene	ND	ug/L	1.0	0.21	1		09/20/16 04:16	106-46-7	
trans-1,4-Dichloro-2-butene	ND	ug/L	10.0	0.45	1		09/20/16 04:16	110-57-6	CH,L3
Dichlorodifluoromethane	ND	ug/L	1.0	0.23	1		09/20/16 04:16	75-71-8	
1,1-Dichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 04:16	75-34-3	
1,2-Dichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 04:16	107-06-2	
1,1-Dichloroethene	ND	ug/L	1.0	0.28	1		09/20/16 04:16	75-35-4	
cis-1,2-Dichloroethene	**0.78J**	ug/L	1.0	0.12	1		09/20/16 04:16	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	1.0	0.16	1		09/20/16 04:16	156-60-5	
1,2-Dichloropropane	ND	ug/L	4.0	0.22	1		09/20/16 04:16	78-87-5	
cis-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		09/20/16 04:16	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		09/20/16 04:16	10061-02-6	
Ethylbenzene	ND	ug/L	1.0	0.15	1		09/20/16 04:16	100-41-4	
2-Hexanone	ND	ug/L	5.0	0.19	1		09/20/16 04:16	591-78-6	
Iodomethane	ND	ug/L	4.0	0.18	1		09/20/16 04:16	74-88-4	
Methylene Chloride	ND	ug/L	4.0	0.29	1		09/20/16 04:16	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.43	1		09/20/16 04:16	108-10-1	
Styrene	ND	ug/L	1.0	0.29	1		09/20/16 04:16	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	4.0	0.17	1		09/20/16 04:16	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0	0.22	1		09/20/16 04:16	79-34-5	
Tetrachloroethene	**0.32J**	ug/L	1.0	0.25	1		09/20/16 04:16	127-18-4	
Toluene	ND	ug/L	1.0	0.14	1		09/20/16 04:16	108-88-3	
1,1,1-Trichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 04:16	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	1.0	0.15	1		09/20/16 04:16	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.20	1		09/20/16 04:16	79-01-6	
Trichlorofluoromethane	ND	ug/L	1.0	0.33	1		09/20/16 04:16	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.28	1		09/20/16 04:16	96-18-4	
Vinyl acetate	ND	ug/L	10.0	0.12	1		09/20/16 04:16	108-05-4	

ANALYTICAL RESULTS

Project: OLD LANDFILL
Pace Project No.: 10361997

Sample: BSB-GW-02-090716 **Lab ID: 10361997002** Collected: 09/07/16 12:23 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Vinyl chloride	ND	ug/L	0.40	0.15	1		09/20/16 04:16	75-01-4	
Xylene (Total)	ND	ug/L	3.0	0.32	1		09/20/16 04:16	1330-20-7	
m&p-Xylene	ND	ug/L	2.0	0.11	1		09/20/16 04:16	179601-23-1	
o-Xylene	ND	ug/L	1.0	0.20	1		09/20/16 04:16	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	112	%.	75-125		1		09/20/16 04:16	17060-07-0	
Toluene-d8 (S)	99	%.	75-125		1		09/20/16 04:16	2037-26-5	
4-Bromofluorobenzene (S)	96	%.	75-125		1		09/20/16 04:16	460-00-4	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**530**	umhos/cm	1.0	1.0	1		09/23/16 15:16		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**6.7**	Std. Units	0.10	0.10	1		09/14/16 13:23		H6
410.4 COD	Analytical Method: EPA 410.4 Preparation Method: EPA 410.4								
Chemical Oxygen Demand	ND	mg/L	50.0	5.4	1	09/15/16 11:47	09/15/16 15:02		
SM4500NO3-H, NO2 + NO3 pres.	Analytical Method: SM 4500-NO3 H								
Nitrate as N	**0.27**	mg/L	0.10	0.018	1		09/20/16 13:42	14797-55-8	
Nitrogen, NO2 plus NO3	**0.27**	mg/L	0.10	0.050	1		09/20/16 13:42		
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**102**	mg/L	12.5	5.2	5		09/16/16 11:37	14808-79-8	
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	**20.9**	mg/L	1.0	0.45	1		09/15/16 10:47	16887-00-6	
SM4500CN-E Cyanide	Analytical Method: SM 4500-CN-E Preparation Method: SM 4500-CN-E								
Cyanide	ND	ug/L	10.0	4.2	1	09/21/16 10:40	09/21/16 16:21	57-12-5	

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ANALYTICAL RESULTS

Project: OLD LANDFILL
Pace Project No.: 10361997

Sample: BSB-GW-03-090716 **Lab ID: 10361997003** Collected: 09/07/16 12:55 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Acetone	ND	ug/L	20.0	2.0	1		09/20/16 05:22	67-64-1	
Acrylonitrile	ND	ug/L	10.0	0.49	1		09/20/16 05:22	107-13-1	
Benzene	ND	ug/L	1.0	0.16	1		09/20/16 05:22	71-43-2	
Bromochloromethane	ND	ug/L	1.0	0.19	1		09/20/16 05:22	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.24	1		09/20/16 05:22	75-27-4	
Bromoform	ND	ug/L	4.0	0.27	1		09/20/16 05:22	75-25-2	
Bromomethane	ND	ug/L	4.0	0.44	1		09/20/16 05:22	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		09/20/16 05:22	78-93-3	
Carbon disulfide	ND	ug/L	1.0	0.30	1		09/20/16 05:22	75-15-0	
Carbon tetrachloride	ND	ug/L	4.0	0.20	1		09/20/16 05:22	56-23-5	
Chlorobenzene	ND	ug/L	1.0	0.11	1		09/20/16 05:22	108-90-7	
Chloroethane	ND	ug/L	1.0	0.34	1		09/20/16 05:22	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		09/20/16 05:22	67-66-3	
Chloromethane	ND	ug/L	4.0	0.25	1		09/20/16 05:22	74-87-3	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		09/20/16 05:22	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	0.16	1		09/20/16 05:22	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.20	1		09/20/16 05:22	106-93-4	
Dibromomethane	ND	ug/L	4.0	0.19	1		09/20/16 05:22	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	1.0	0.17	1		09/20/16 05:22	95-50-1	
1,4-Dichlorobenzene	ND	ug/L	1.0	0.21	1		09/20/16 05:22	106-46-7	
trans-1,4-Dichloro-2-butene	ND	ug/L	10.0	0.45	1		09/20/16 05:22	110-57-6	L3
Dichlorodifluoromethane	ND	ug/L	1.0	0.23	1		09/20/16 05:22	75-71-8	
1,1-Dichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 05:22	75-34-3	
1,2-Dichloroethane	**0.57J**	ug/L	1.0	0.17	1		09/20/16 05:22	107-06-2	
1,1-Dichloroethene	ND	ug/L	1.0	0.28	1		09/20/16 05:22	75-35-4	
cis-1,2-Dichloroethene	**2.4**	ug/L	1.0	0.12	1		09/20/16 05:22	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	1.0	0.16	1		09/20/16 05:22	156-60-5	
1,2-Dichloropropane	ND	ug/L	4.0	0.22	1		09/20/16 05:22	78-87-5	
cis-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		09/20/16 05:22	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		09/20/16 05:22	10061-02-6	
Ethylbenzene	ND	ug/L	1.0	0.15	1		09/20/16 05:22	100-41-4	
2-Hexanone	ND	ug/L	5.0	0.19	1		09/20/16 05:22	591-78-6	
Iodomethane	ND	ug/L	4.0	0.18	1		09/20/16 05:22	74-88-4	
Methylene Chloride	ND	ug/L	4.0	0.29	1		09/20/16 05:22	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.43	1		09/20/16 05:22	108-10-1	
Styrene	ND	ug/L	1.0	0.29	1		09/20/16 05:22	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	4.0	0.17	1		09/20/16 05:22	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0	0.22	1		09/20/16 05:22	79-34-5	
Tetrachloroethene	**0.80J**	ug/L	1.0	0.25	1		09/20/16 05:22	127-18-4	
Toluene	ND	ug/L	1.0	0.14	1		09/20/16 05:22	108-88-3	
1,1,1-Trichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 05:22	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	1.0	0.15	1		09/20/16 05:22	79-00-5	
Trichloroethene	**0.29J**	ug/L	0.40	0.20	1		09/20/16 05:22	79-01-6	
Trichlorofluoromethane	ND	ug/L	1.0	0.33	1		09/20/16 05:22	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.28	1		09/20/16 05:22	96-18-4	
Vinyl acetate	ND	ug/L	10.0	0.12	1		09/20/16 05:22	108-05-4	

ANALYTICAL RESULTS

Project: OLD LANDFILL
Pace Project No.: 10361997

Sample: BSB-GW-03-090716 **Lab ID: 10361997003** Collected: 09/07/16 12:55 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Vinyl chloride	ND	ug/L	0.40	0.15	1		09/20/16 05:22	75-01-4	
Xylene (Total)	ND	ug/L	3.0	0.32	1		09/20/16 05:22	1330-20-7	
m&p-Xylene	ND	ug/L	2.0	0.11	1		09/20/16 05:22	179601-23-1	
o-Xylene	ND	ug/L	1.0	0.20	1		09/20/16 05:22	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	112	%.	75-125		1		09/20/16 05:22	17060-07-0	
Toluene-d8 (S)	101	%.	75-125		1		09/20/16 05:22	2037-26-5	
4-Bromofluorobenzene (S)	96	%.	75-125		1		09/20/16 05:22	460-00-4	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**1390**	umhos/cm	1.0	1.0	1		09/23/16 15:17		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**5.9**	Std. Units	0.10	0.10	1		09/14/16 13:28		H6
410.4 COD	Analytical Method: EPA 410.4 Preparation Method: EPA 410.4								
Chemical Oxygen Demand	**10.0J**	mg/L	50.0	5.4	1	09/15/16 11:47	09/15/16 15:03		
SM4500NO3-H, NO2 + NO3 pres.	Analytical Method: SM 4500-NO3 H								
Nitrate as N	**0.55**	mg/L	0.10	0.018	1		09/20/16 13:45	14797-55-8	
Nitrogen, NO2 plus NO3	**0.55**	mg/L	0.10	0.050	1		09/20/16 13:45		
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**692**	mg/L	62.5	26.0	25		09/16/16 11:48	14808-79-8	
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	**36.6**	mg/L	2.0	0.90	2		09/15/16 11:08	16887-00-6	
SM4500CN-E Cyanide	Analytical Method: SM 4500-CN-E Preparation Method: SM 4500-CN-E								
Cyanide	ND	ug/L	10.0	4.2	1	09/21/16 10:40	09/21/16 16:22	57-12-5	

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ANALYTICAL RESULTS

Project: OLD LANDFILL
Pace Project No.: 10361997

Sample: BSB-GW-04-090716 **Lab ID: 10361997004** Collected: 09/07/16 14:25 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Acetone	**6.6J**	ug/L	20.0	2.0	1		09/20/16 05:44	67-64-1	
Acrylonitrile	ND	ug/L	10.0	0.49	1		09/20/16 05:44	107-13-1	
Benzene	**0.50J**	ug/L	1.0	0.16	1		09/20/16 05:44	71-43-2	
Bromochloromethane	ND	ug/L	1.0	0.19	1		09/20/16 05:44	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.24	1		09/20/16 05:44	75-27-4	
Bromoform	ND	ug/L	4.0	0.27	1		09/20/16 05:44	75-25-2	
Bromomethane	ND	ug/L	4.0	0.44	1		09/20/16 05:44	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		09/20/16 05:44	78-93-3	
Carbon disulfide	ND	ug/L	1.0	0.30	1		09/20/16 05:44	75-15-0	
Carbon tetrachloride	ND	ug/L	4.0	0.20	1		09/20/16 05:44	56-23-5	
Chlorobenzene	ND	ug/L	1.0	0.11	1		09/20/16 05:44	108-90-7	
Chloroethane	ND	ug/L	1.0	0.34	1		09/20/16 05:44	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		09/20/16 05:44	67-66-3	
Chloromethane	ND	ug/L	4.0	0.25	1		09/20/16 05:44	74-87-3	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		09/20/16 05:44	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	0.16	1		09/20/16 05:44	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.20	1		09/20/16 05:44	106-93-4	
Dibromomethane	ND	ug/L	4.0	0.19	1		09/20/16 05:44	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	1.0	0.17	1		09/20/16 05:44	95-50-1	
1,4-Dichlorobenzene	**1.3**	ug/L	1.0	0.21	1		09/20/16 05:44	106-46-7	
trans-1,4-Dichloro-2-butene	ND	ug/L	10.0	0.45	1		09/20/16 05:44	110-57-6	L3
Dichlorodifluoromethane	**1.3**	ug/L	1.0	0.23	1		09/20/16 05:44	75-71-8	
1,1-Dichloroethane	**1.4**	ug/L	1.0	0.17	1		09/20/16 05:44	75-34-3	
1,2-Dichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 05:44	107-06-2	
1,1-Dichloroethene	ND	ug/L	1.0	0.28	1		09/20/16 05:44	75-35-4	
cis-1,2-Dichloroethene	**2.3**	ug/L	1.0	0.12	1		09/20/16 05:44	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	1.0	0.16	1		09/20/16 05:44	156-60-5	
1,2-Dichloropropane	**0.60J**	ug/L	4.0	0.22	1		09/20/16 05:44	78-87-5	
cis-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		09/20/16 05:44	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		09/20/16 05:44	10061-02-6	
Ethylbenzene	ND	ug/L	1.0	0.15	1		09/20/16 05:44	100-41-4	
2-Hexanone	ND	ug/L	5.0	0.19	1		09/20/16 05:44	591-78-6	
Iodomethane	ND	ug/L	4.0	0.18	1		09/20/16 05:44	74-88-4	
Methylene Chloride	**0.46J**	ug/L	4.0	0.29	1		09/20/16 05:44	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.43	1		09/20/16 05:44	108-10-1	
Styrene	ND	ug/L	1.0	0.29	1		09/20/16 05:44	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	4.0	0.17	1		09/20/16 05:44	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0	0.22	1		09/20/16 05:44	79-34-5	
Tetrachloroethene	ND	ug/L	1.0	0.25	1		09/20/16 05:44	127-18-4	
Toluene	ND	ug/L	1.0	0.14	1		09/20/16 05:44	108-88-3	
1,1,1-Trichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 05:44	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	1.0	0.15	1		09/20/16 05:44	79-00-5	
Trichloroethene	**0.21J**	ug/L	0.40	0.20	1		09/20/16 05:44	79-01-6	
Trichlorofluoromethane	ND	ug/L	1.0	0.33	1		09/20/16 05:44	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.28	1		09/20/16 05:44	96-18-4	
Vinyl acetate	ND	ug/L	10.0	0.12	1		09/20/16 05:44	108-05-4	

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ANALYTICAL RESULTS

Project: OLD LANDFILL
Pace Project No.: 10361997

Sample: BSB-GW-04-090716 **Lab ID: 10361997004** Collected: 09/07/16 14:25 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Vinyl chloride	**1.4**	ug/L	0.40	0.15	1		09/20/16 05:44	75-01-4	
Xylene (Total)	ND	ug/L	3.0	0.32	1		09/20/16 05:44	1330-20-7	
m&p-Xylene	ND	ug/L	2.0	0.11	1		09/20/16 05:44	179601-23-1	
o-Xylene	ND	ug/L	1.0	0.20	1		09/20/16 05:44	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	111	%.	75-125		1		09/20/16 05:44	17060-07-0	
Toluene-d8 (S)	101	%.	75-125		1		09/20/16 05:44	2037-26-5	
4-Bromofluorobenzene (S)	93	%.	75-125		1		09/20/16 05:44	460-00-4	
120.1 Specific Conductance	Analytical Method: EPA 120.1								
Specific Conductance	**2700**	umhos/cm	1.0	1.0	1		09/23/16 15:18		
4500H+ pH, Electrometric	Analytical Method: SM 4500-H+B								
pH at 25 Degrees C	**5.6**	Std. Units	0.10	0.10	1		09/23/16 13:43		H6
410.4 COD	Analytical Method: EPA 410.4 Preparation Method: EPA 410.4								
Chemical Oxygen Demand	**418**	mg/L	50.0	5.4	1	09/15/16 11:47	09/15/16 15:03		
SM4500NO3-H, NO2 + NO3 pres.	Analytical Method: SM 4500-NO3 H								
Nitrate as N	**0.39**	mg/L	0.10	0.018	1		09/20/16 13:45	14797-55-8	
Nitrogen, NO2 plus NO3	**0.39**	mg/L	0.10	0.050	1		09/20/16 13:45		
ASTM D516 Sulfate Water	Analytical Method: ASTM D516								
Sulfate	**1220**	mg/L	125	52.0	50		09/16/16 11:41	14808-79-8	
SM4500Cl-E Chloride	Analytical Method: SM 4500-Cl E								
Chloride	**83.2**	mg/L	5.0	2.2	5		09/15/16 11:19	16887-00-6	
SM4500CN-E Cyanide	Analytical Method: SM 4500-CN-E Preparation Method: SM 4500-CN-E								
Cyanide	**10J**	ug/L	10.0	4.2	1	09/21/16 10:40	09/21/16 16:22	57-12-5	

ANALYTICAL RESULTS

Project: OLD LANDFILL
Pace Project No.: 10361997

Sample: BSB-GW-07-090716 **Lab ID: 10361997005** Collected: 09/07/16 14:40 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Acetone	**6.8J**	ug/L	20.0	2.0	1		09/20/16 06:06	67-64-1	
Acrylonitrile	ND	ug/L	10.0	0.49	1		09/20/16 06:06	107-13-1	
Benzene	**0.46J**	ug/L	1.0	0.16	1		09/20/16 06:06	71-43-2	
Bromochloromethane	ND	ug/L	1.0	0.19	1		09/20/16 06:06	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.24	1		09/20/16 06:06	75-27-4	
Bromoform	ND	ug/L	4.0	0.27	1		09/20/16 06:06	75-25-2	
Bromomethane	ND	ug/L	4.0	0.44	1		09/20/16 06:06	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		09/20/16 06:06	78-93-3	
Carbon disulfide	ND	ug/L	1.0	0.30	1		09/20/16 06:06	75-15-0	
Carbon tetrachloride	ND	ug/L	4.0	0.20	1		09/20/16 06:06	56-23-5	
Chlorobenzene	ND	ug/L	1.0	0.11	1		09/20/16 06:06	108-90-7	
Chloroethane	ND	ug/L	1.0	0.34	1		09/20/16 06:06	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		09/20/16 06:06	67-66-3	
Chloromethane	ND	ug/L	4.0	0.25	1		09/20/16 06:06	74-87-3	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		09/20/16 06:06	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	0.16	1		09/20/16 06:06	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.20	1		09/20/16 06:06	106-93-4	
Dibromomethane	ND	ug/L	4.0	0.19	1		09/20/16 06:06	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	1.0	0.17	1		09/20/16 06:06	95-50-1	
1,4-Dichlorobenzene	**1.5**	ug/L	1.0	0.21	1		09/20/16 06:06	106-46-7	
trans-1,4-Dichloro-2-butene	ND	ug/L	10.0	0.45	1		09/20/16 06:06	110-57-6	L3
Dichlorodifluoromethane	**1.4**	ug/L	1.0	0.23	1		09/20/16 06:06	75-71-8	
1,1-Dichloroethane	**1.5**	ug/L	1.0	0.17	1		09/20/16 06:06	75-34-3	
1,2-Dichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 06:06	107-06-2	
1,1-Dichloroethene	ND	ug/L	1.0	0.28	1		09/20/16 06:06	75-35-4	
cis-1,2-Dichloroethene	**2.2**	ug/L	1.0	0.12	1		09/20/16 06:06	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	1.0	0.16	1		09/20/16 06:06	156-60-5	
1,2-Dichloropropane	**0.55J**	ug/L	4.0	0.22	1		09/20/16 06:06	78-87-5	
cis-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		09/20/16 06:06	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		09/20/16 06:06	10061-02-6	
Ethylbenzene	ND	ug/L	1.0	0.15	1		09/20/16 06:06	100-41-4	
2-Hexanone	ND	ug/L	5.0	0.19	1		09/20/16 06:06	591-78-6	
Iodomethane	ND	ug/L	4.0	0.18	1		09/20/16 06:06	74-88-4	
Methylene Chloride	ND	ug/L	4.0	0.29	1		09/20/16 06:06	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.43	1		09/20/16 06:06	108-10-1	
Styrene	ND	ug/L	1.0	0.29	1		09/20/16 06:06	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	4.0	0.17	1		09/20/16 06:06	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0	0.22	1		09/20/16 06:06	79-34-5	
Tetrachloroethene	ND	ug/L	1.0	0.25	1		09/20/16 06:06	127-18-4	
Toluene	ND	ug/L	1.0	0.14	1		09/20/16 06:06	108-88-3	
1,1,1-Trichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 06:06	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	1.0	0.15	1		09/20/16 06:06	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.20	1		09/20/16 06:06	79-01-6	
Trichlorofluoromethane	ND	ug/L	1.0	0.33	1		09/20/16 06:06	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.28	1		09/20/16 06:06	96-18-4	
Vinyl acetate	ND	ug/L	10.0	0.12	1		09/20/16 06:06	108-05-4	

ANALYTICAL RESULTS

Project: OLD LANDFILL
Pace Project No.: 10361997

Sample: BSB-GW-07-090716 **Lab ID: 10361997005** Collected: 09/07/16 14:40 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Vinyl chloride	**1.5**	ug/L	0.40	0.15	1		09/20/16 06:06	75-01-4	
Xylene (Total)	ND	ug/L	3.0	0.32	1		09/20/16 06:06	1330-20-7	
m&p-Xylene	ND	ug/L	2.0	0.11	1		09/20/16 06:06	179601-23-1	
o-Xylene	ND	ug/L	1.0	0.20	1		09/20/16 06:06	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	111	%.	75-125		1		09/20/16 06:06	17060-07-0	
Toluene-d8 (S)	99	%.	75-125		1		09/20/16 06:06	2037-26-5	
4-Bromofluorobenzene (S)	93	%.	75-125		1		09/20/16 06:06	460-00-4	

ANALYTICAL RESULTS

Project: OLD LANDFILL
Pace Project No.: 10361997

Sample: Trip Blank **Lab ID: 10361997006** Collected: 09/07/16 00:00 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Acetone	ND	ug/L	20.0	2.0	1		09/20/16 03:33	67-64-1	
Acrylonitrile	ND	ug/L	10.0	0.49	1		09/20/16 03:33	107-13-1	
Benzene	ND	ug/L	1.0	0.16	1		09/20/16 03:33	71-43-2	
Bromochloromethane	ND	ug/L	1.0	0.19	1		09/20/16 03:33	74-97-5	
Bromodichloromethane	ND	ug/L	1.0	0.24	1		09/20/16 03:33	75-27-4	
Bromoform	ND	ug/L	4.0	0.27	1		09/20/16 03:33	75-25-2	
Bromomethane	ND	ug/L	4.0	0.44	1		09/20/16 03:33	74-83-9	
2-Butanone (MEK)	ND	ug/L	5.0	1.1	1		09/20/16 03:33	78-93-3	
Carbon disulfide	ND	ug/L	1.0	0.30	1		09/20/16 03:33	75-15-0	
Carbon tetrachloride	ND	ug/L	4.0	0.20	1		09/20/16 03:33	56-23-5	
Chlorobenzene	ND	ug/L	1.0	0.11	1		09/20/16 03:33	108-90-7	
Chloroethane	ND	ug/L	1.0	0.34	1		09/20/16 03:33	75-00-3	
Chloroform	ND	ug/L	1.0	0.21	1		09/20/16 03:33	67-66-3	
Chloromethane	ND	ug/L	4.0	0.25	1		09/20/16 03:33	74-87-3	
1,2-Dibromo-3-chloropropane	ND	ug/L	10.0	0.60	1		09/20/16 03:33	96-12-8	
Dibromochloromethane	ND	ug/L	4.0	0.16	1		09/20/16 03:33	124-48-1	
1,2-Dibromoethane (EDB)	ND	ug/L	1.0	0.20	1		09/20/16 03:33	106-93-4	
Dibromomethane	ND	ug/L	4.0	0.19	1		09/20/16 03:33	74-95-3	
1,2-Dichlorobenzene	ND	ug/L	1.0	0.17	1		09/20/16 03:33	95-50-1	
1,4-Dichlorobenzene	ND	ug/L	1.0	0.21	1		09/20/16 03:33	106-46-7	
trans-1,4-Dichloro-2-butene	ND	ug/L	10.0	0.45	1		09/20/16 03:33	110-57-6	L3
Dichlorodifluoromethane	ND	ug/L	1.0	0.23	1		09/20/16 03:33	75-71-8	
1,1-Dichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 03:33	75-34-3	
1,2-Dichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 03:33	107-06-2	
1,1-Dichloroethene	ND	ug/L	1.0	0.28	1		09/20/16 03:33	75-35-4	
cis-1,2-Dichloroethene	ND	ug/L	1.0	0.12	1		09/20/16 03:33	156-59-2	
trans-1,2-Dichloroethene	ND	ug/L	1.0	0.16	1		09/20/16 03:33	156-60-5	
1,2-Dichloropropane	ND	ug/L	4.0	0.22	1		09/20/16 03:33	78-87-5	
cis-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		09/20/16 03:33	10061-01-5	
trans-1,3-Dichloropropene	ND	ug/L	4.0	0.15	1		09/20/16 03:33	10061-02-6	
Ethylbenzene	ND	ug/L	1.0	0.15	1		09/20/16 03:33	100-41-4	
2-Hexanone	ND	ug/L	5.0	0.19	1		09/20/16 03:33	591-78-6	
Iodomethane	ND	ug/L	4.0	0.18	1		09/20/16 03:33	74-88-4	
Methylene Chloride	**0.41J**	ug/L	4.0	0.29	1		09/20/16 03:33	75-09-2	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	5.0	0.43	1		09/20/16 03:33	108-10-1	
Styrene	ND	ug/L	1.0	0.29	1		09/20/16 03:33	100-42-5	
1,1,1,2-Tetrachloroethane	ND	ug/L	4.0	0.17	1		09/20/16 03:33	630-20-6	
1,1,2,2-Tetrachloroethane	ND	ug/L	1.0	0.22	1		09/20/16 03:33	79-34-5	
Tetrachloroethene	ND	ug/L	1.0	0.25	1		09/20/16 03:33	127-18-4	
Toluene	ND	ug/L	1.0	0.14	1		09/20/16 03:33	108-88-3	
1,1,1-Trichloroethane	ND	ug/L	1.0	0.17	1		09/20/16 03:33	71-55-6	
1,1,2-Trichloroethane	ND	ug/L	1.0	0.15	1		09/20/16 03:33	79-00-5	
Trichloroethene	ND	ug/L	0.40	0.20	1		09/20/16 03:33	79-01-6	
Trichlorofluoromethane	ND	ug/L	1.0	0.33	1		09/20/16 03:33	75-69-4	
1,2,3-Trichloropropane	ND	ug/L	4.0	0.28	1		09/20/16 03:33	96-18-4	
Vinyl acetate	ND	ug/L	10.0	0.12	1		09/20/16 03:33	108-05-4	

ANALYTICAL RESULTS

Project: OLD LANDFILL
Pace Project No.: 10361997

Sample: Trip Blank **Lab ID: 10361997006** Collected: 09/07/16 00:00 Received: 09/10/16 09:45 Matrix: Water

Parameters	Results	Units	Report Limit	MDL	DF	Prepared	Analyzed	CAS No.	Qual
8260B MSV	Analytical Method: EPA 8260B								
Vinyl chloride	ND	ug/L	0.40	0.15	1		09/20/16 03:33	75-01-4	
Xylene (Total)	ND	ug/L	3.0	0.32	1		09/20/16 03:33	1330-20-7	
m&p-Xylene	ND	ug/L	2.0	0.11	1		09/20/16 03:33	179601-23-1	
o-Xylene	ND	ug/L	1.0	0.20	1		09/20/16 03:33	95-47-6	
Surrogates									
1,2-Dichloroethane-d4 (S)	113	%.	75-125		1		09/20/16 03:33	17060-07-0	
Toluene-d8 (S)	99	%.	75-125		1		09/20/16 03:33	2037-26-5	
4-Bromofluorobenzene (S)	95	%.	75-125		1		09/20/16 03:33	460-00-4	

QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

QC Batch: 436255 Analysis Method: EPA 6020A
QC Batch Method: EPA 3020 Analysis Description: 6020A Water Dissolved UPD4
Associated Lab Samples: 10361997001

METHOD BLANK: 2370974 Matrix: Water
Associated Lab Samples: 10361997001

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Antimony, Dissolved	mg/L	ND	0.00050	0.000032	09/20/16 14:33	
Arsenic, Dissolved	mg/L	ND	0.00050	0.000091	09/20/16 14:33	
Barium, Dissolved	mg/L	ND	0.00030	0.000019	09/20/16 14:33	
Beryllium, Dissolved	mg/L	ND	0.00020	0.000030	09/20/16 14:33	
Cadmium, Dissolved	mg/L	ND	0.000080	0.000013	09/20/16 14:33	
Chromium, Dissolved	mg/L	ND	0.00050	0.00014	09/20/16 14:33	
Cobalt, Dissolved	mg/L	ND	0.00050	0.000021	09/20/16 14:33	
Copper, Dissolved	mg/L	ND	0.0010	0.00040	09/20/16 14:33	
Iron, Dissolved	mg/L	ND	0.050	0.018	09/20/16 14:33	
Lead, Dissolved	mg/L	ND	0.00010	0.000012	09/20/16 14:33	
Nickel, Dissolved	mg/L	0.00032J	0.00050	0.000099	09/20/16 14:33	
Selenium, Dissolved	mg/L	ND	0.00050	0.00013	09/20/16 14:33	
Vanadium, Dissolved	mg/L	ND	0.0010	0.000085	09/20/16 14:33	
Zinc, Dissolved	mg/L	0.0011J	0.0050	0.00078	09/20/16 14:33	

LABORATORY CONTROL SAMPLE: 2370975

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Antimony, Dissolved	mg/L	.1	0.10	103	80-120	
Arsenic, Dissolved	mg/L	.1	0.10	101	80-120	
Barium, Dissolved	mg/L	.1	0.10	102	80-120	
Beryllium, Dissolved	mg/L	.1	0.11	112	80-120	
Cadmium, Dissolved	mg/L	.1	0.10	103	80-120	
Chromium, Dissolved	mg/L	.1	0.10	101	80-120	
Cobalt, Dissolved	mg/L	.1	0.10	103	80-120	
Copper, Dissolved	mg/L	.1	0.10	105	80-120	
Iron, Dissolved	mg/L	2	2.0	101	80-120	
Lead, Dissolved	mg/L	.1	0.10	104	80-120	
Nickel, Dissolved	mg/L	.1	0.10	104	80-120	
Selenium, Dissolved	mg/L	.1	0.10	104	80-120	
Vanadium, Dissolved	mg/L	.1	0.10	101	80-120	
Zinc, Dissolved	mg/L	.1	0.11	107	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2370976 2370977

Parameter	Units	10361997001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Antimony, Dissolved	mg/L	0.00026J	.1	.1	0.10	0.11	102	105	75-125	4	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2370976 2370977

Parameter	Units	10361997001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Arsenic, Dissolved	mg/L	0.0012	.1	.1	0.10	0.10	99	103	75-125	4	20	
Barium, Dissolved	mg/L	0.16	.1	.1	0.26	0.27	97	106	75-125	3	20	
Beryllium, Dissolved	mg/L	ND	.1	.1	0.11	0.11	107	110	75-125	3	20	
Cadmium, Dissolved	mg/L	0.000020J	.1	.1	0.10	0.10	100	104	75-125	4	20	
Chromium, Dissolved	mg/L	0.00028J	.1	.1	0.099	0.10	99	102	75-125	3	20	
Cobalt, Dissolved	mg/L	0.00028J	.1	.1	0.10	0.10	100	104	75-125	4	20	
Copper, Dissolved	mg/L	0.0012	.1	.1	0.10	0.11	103	105	75-125	2	20	
Iron, Dissolved	mg/L	ND	2	2	2.0	2.0	98	102	75-125	4	20	
Lead, Dissolved	mg/L	ND	.1	.1	0.10	0.10	100	103	75-125	3	20	
Nickel, Dissolved	mg/L	0.00018J	.1	.1	0.10	0.10	101	105	75-125	4	20	
Selenium, Dissolved	mg/L	0.00072	.1	.1	0.10	0.11	101	106	75-125	5	20	
Vanadium, Dissolved	mg/L	0.0062	.1	.1	0.10	0.11	98	103	75-125	5	20	
Zinc, Dissolved	mg/L	0.0043J	.1	.1	0.11	0.11	104	107	75-125	3	20	

QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

QC Batch: 436367
QC Batch Method: EPA 8260B
Analysis Method: EPA 8260B
Analysis Description: 8260B MSV
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004, 10361997005, 10361997006

METHOD BLANK: 2371483
Matrix: Water
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004, 10361997005, 10361997006

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	ND	4.0	0.17	09/20/16 02:49	
1,1,1-Trichloroethane	ug/L	ND	1.0	0.17	09/20/16 02:49	
1,1,2,2-Tetrachloroethane	ug/L	ND	1.0	0.22	09/20/16 02:49	
1,1,2-Trichloroethane	ug/L	ND	1.0	0.15	09/20/16 02:49	
1,1-Dichloroethane	ug/L	ND	1.0	0.17	09/20/16 02:49	
1,1-Dichloroethene	ug/L	ND	1.0	0.28	09/20/16 02:49	
1,2,3-Trichloropropane	ug/L	ND	4.0	0.28	09/20/16 02:49	
1,2-Dibromo-3-chloropropane	ug/L	ND	10.0	0.60	09/20/16 02:49	
1,2-Dibromoethane (EDB)	ug/L	ND	1.0	0.20	09/20/16 02:49	
1,2-Dichlorobenzene	ug/L	ND	1.0	0.17	09/20/16 02:49	
1,2-Dichloroethane	ug/L	ND	1.0	0.17	09/20/16 02:49	
1,2-Dichloropropane	ug/L	ND	4.0	0.22	09/20/16 02:49	
1,4-Dichlorobenzene	ug/L	ND	1.0	0.21	09/20/16 02:49	
2-Butanone (MEK)	ug/L	ND	5.0	1.1	09/20/16 02:49	
2-Hexanone	ug/L	ND	5.0	0.19	09/20/16 02:49	
4-Methyl-2-pentanone (MIBK)	ug/L	ND	5.0	0.43	09/20/16 02:49	
Acetone	ug/L	ND	20.0	2.0	09/20/16 02:49	
Acrylonitrile	ug/L	ND	10.0	0.49	09/20/16 02:49	
Benzene	ug/L	ND	1.0	0.16	09/20/16 02:49	
Bromochloromethane	ug/L	ND	1.0	0.19	09/20/16 02:49	
Bromodichloromethane	ug/L	ND	1.0	0.24	09/20/16 02:49	
Bromoform	ug/L	ND	4.0	0.27	09/20/16 02:49	
Bromomethane	ug/L	ND	4.0	0.44	09/20/16 02:49	
Carbon disulfide	ug/L	ND	1.0	0.30	09/20/16 02:49	
Carbon tetrachloride	ug/L	ND	4.0	0.20	09/20/16 02:49	
Chlorobenzene	ug/L	ND	1.0	0.11	09/20/16 02:49	
Chloroethane	ug/L	ND	1.0	0.34	09/20/16 02:49	
Chloroform	ug/L	ND	1.0	0.21	09/20/16 02:49	
Chloromethane	ug/L	ND	4.0	0.25	09/20/16 02:49	
cis-1,2-Dichloroethene	ug/L	ND	1.0	0.12	09/20/16 02:49	
cis-1,3-Dichloropropene	ug/L	ND	4.0	0.15	09/20/16 02:49	
Dibromochloromethane	ug/L	ND	4.0	0.16	09/20/16 02:49	
Dibromomethane	ug/L	ND	4.0	0.19	09/20/16 02:49	
Dichlorodifluoromethane	ug/L	ND	1.0	0.23	09/20/16 02:49	
Ethylbenzene	ug/L	ND	1.0	0.15	09/20/16 02:49	
Iodomethane	ug/L	ND	4.0	0.18	09/20/16 02:49	
m&p-Xylene	ug/L	ND	2.0	0.11	09/20/16 02:49	
Methylene Chloride	ug/L	ND	4.0	0.29	09/20/16 02:49	
o-Xylene	ug/L	ND	1.0	0.20	09/20/16 02:49	
Styrene	ug/L	ND	1.0	0.29	09/20/16 02:49	
Tetrachloroethene	ug/L	ND	1.0	0.25	09/20/16 02:49	

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QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

METHOD BLANK: 2371483 Matrix: Water
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004, 10361997005, 10361997006

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Toluene	ug/L	ND	1.0	0.14	09/20/16 02:49	
trans-1,2-Dichloroethene	ug/L	ND	1.0	0.16	09/20/16 02:49	
trans-1,3-Dichloropropene	ug/L	ND	4.0	0.15	09/20/16 02:49	
trans-1,4-Dichloro-2-butene	ug/L	ND	10.0	0.45	09/20/16 02:49	
Trichloroethene	ug/L	ND	0.40	0.20	09/20/16 02:49	
Trichlorofluoromethane	ug/L	ND	1.0	0.33	09/20/16 02:49	
Vinyl acetate	ug/L	ND	10.0	0.12	09/20/16 02:49	
Vinyl chloride	ug/L	ND	0.40	0.15	09/20/16 02:49	
Xylene (Total)	ug/L	ND	3.0	0.32	09/20/16 02:49	
1,2-Dichloroethane-d4 (S)	%.	111	75-125		09/20/16 02:49	
4-Bromofluorobenzene (S)	%.	99	75-125		09/20/16 02:49	
Toluene-d8 (S)	%.	100	75-125		09/20/16 02:49	

LABORATORY CONTROL SAMPLE & LCSD: 2371484 2371485

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	20	21.2	20.9	106	105	75-125	1	20	
1,1,1-Trichloroethane	ug/L	20	18.7	17.9	94	89	73-125	4	20	
1,1,2,2-Tetrachloroethane	ug/L	20	19.9	19.7	99	99	75-128	1	20	
1,1,2-Trichloroethane	ug/L	20	20.0	20.1	100	101	75-129	0	20	
1,1-Dichloroethane	ug/L	20	19.6	19.0	98	95	75-131	3	20	
1,1-Dichloroethene	ug/L	20	18.2	17.2	91	86	72-125	6	20	
1,2,3-Trichloropropane	ug/L	20	19.9	19.9	99	100	75-125	0	20	
1,2-Dibromo-3-chloropropane	ug/L	50	49.1	48.1	98	96	74-125	2	20	
1,2-Dibromoethane (EDB)	ug/L	20	19.4	19.3	97	96	75-125	1	20	
1,2-Dichlorobenzene	ug/L	20	19.9	19.6	100	98	75-125	2	20	
1,2-Dichloroethane	ug/L	20	19.2	19.5	96	97	72-129	1	20	
1,2-Dichloropropane	ug/L	20	18.9	18.5	94	92	71-129	2	20	
1,4-Dichlorobenzene	ug/L	20	19.9	18.8	99	94	75-125	5	20	
2-Butanone (MEK)	ug/L	100	93.2	90.7	93	91	58-150	3	20	
2-Hexanone	ug/L	100	95.1	98.4	95	98	68-130	3	20	
4-Methyl-2-pentanone (MIBK)	ug/L	100	93.7	96.2	94	96	72-140	3	20	
Acetone	ug/L	100	113	114	113	114	69-137	1	20	
Acrylonitrile	ug/L	200	187	190	94	95	47-146	2	20	
Benzene	ug/L	20	18.7	17.6	94	88	75-125	6	20	
Bromochloromethane	ug/L	20	18.2	18.1	91	91	75-125	0	20	
Bromodichloromethane	ug/L	20	19.2	19.2	96	96	69-128	0	20	
Bromoform	ug/L	20	20.0	20.7	100	104	75-125	3	20	
Bromomethane	ug/L	20	22.4	22.2	112	111	30-150	1	20	
Carbon disulfide	ug/L	20	17.3	16.4	86	82	44-137	5	20	
Carbon tetrachloride	ug/L	20	19.5	18.2	97	91	74-125	7	20	
Chlorobenzene	ug/L	20	19.2	18.4	96	92	75-125	5	20	
Chloroethane	ug/L	20	20.5	19.5	103	97	60-150	5	20	
Chloroform	ug/L	20	17.9	17.0	89	85	75-126	5	20	

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QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

LABORATORY CONTROL SAMPLE & LCSD: 2371484 2371485

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Chloromethane	ug/L	20	20.5	19.5	102	98	46-150	5	20	
cis-1,2-Dichloroethene	ug/L	20	18.0	16.9	90	84	75-126	7	20	
cis-1,3-Dichloropropene	ug/L	20	19.0	19.3	95	96	75-125	2	20	
Dibromochloromethane	ug/L	20	19.3	19.6	96	98	75-125	2	20	
Dibromomethane	ug/L	20	20.2	20.6	101	103	72-127	2	20	
Dichlorodifluoromethane	ug/L	20	18.4	17.1	92	86	58-135	7	20	
Ethylbenzene	ug/L	20	19.1	18.2	95	91	75-125	5	20	
Iodomethane	ug/L	20	19.5	18.4	97	92	30-142	6	20	
m&p-Xylene	ug/L	40	40.1	38.6	100	96	72-126	4	20	
Methylene Chloride	ug/L	20	19.7	18.9	99	95	71-130	4	20	
o-Xylene	ug/L	20	20.7	20.1	103	101	75-125	3	20	
Styrene	ug/L	20	21.8	21.3	109	107	75-125	2	20	
Tetrachloroethene	ug/L	20	18.2	17.1	91	86	75-125	6	20	
Toluene	ug/L	20	18.7	18.0	93	90	75-125	4	20	
trans-1,2-Dichloroethene	ug/L	20	19.5	18.1	97	91	75-125	7	20	
trans-1,3-Dichloropropene	ug/L	20	20.0	19.8	100	99	75-125	1	20	
trans-1,4-Dichloro-2-butene	ug/L	50	69.1	69.4	138	139	52-131	0	20	CH,L0
Trichloroethene	ug/L	20	18.6	17.9	93	90	75-125	4	20	
Trichlorofluoromethane	ug/L	20	20.6	18.9	103	94	74-128	9	20	
Vinyl acetate	ug/L	20	14.5	15.0	72	75	52-135	4	20	
Vinyl chloride	ug/L	20	18.3	17.9	92	90	71-131	2	20	
Xylene (Total)	ug/L	60	60.8	58.7	101	98	75-125	4	20	
1,2-Dichloroethane-d4 (S)	%.				102	104	75-125			
4-Bromofluorobenzene (S)	%.				97	96	75-125			
Toluene-d8 (S)	%.				98	98	75-125			

MATRIX SPIKE SAMPLE: 2371588

Parameter	Units	10361997002 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	ND	20	19.7	98	75-125	
1,1,1-Trichloroethane	ug/L	ND	20	19.2	96	71-144	
1,1,2,2-Tetrachloroethane	ug/L	ND	20	18.4	92	75-131	
1,1,2-Trichloroethane	ug/L	ND	20	18.4	92	75-125	
1,1-Dichloroethane	ug/L	ND	20	19.0	95	64-150	
1,1-Dichloroethene	ug/L	ND	20	19.1	96	68-150	
1,2,3-Trichloropropane	ug/L	ND	20	19.2	96	75-125	
1,2-Dibromo-3-chloropropane	ug/L	ND	50	44.9	90	32-137	
1,2-Dibromoethane (EDB)	ug/L	ND	20	17.7	89	75-125	
1,2-Dichlorobenzene	ug/L	ND	20	18.4	92	75-125	
1,2-Dichloroethane	ug/L	ND	20	18.2	91	62-138	
1,2-Dichloropropane	ug/L	ND	20	18.4	92	62-144	
1,4-Dichlorobenzene	ug/L	ND	20	17.9	89	74-126	
2-Butanone (MEK)	ug/L	ND	100	87.1	87	47-150	
2-Hexanone	ug/L	ND	100	89.3	89	64-134	
4-Methyl-2-pentanone (MIBK)	ug/L	ND	100	90.2	90	60-147	

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QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

MATRIX SPIKE SAMPLE: 2371588

Parameter	Units	10361997002 Result	Spike Conc.	MS Result	MS % Rec	% Rec Limits	Qualifiers
Acetone	ug/L	ND	100	108	108	61-150	
Acrylonitrile	ug/L	ND	200	179	90	44-141	
Benzene	ug/L	ND	20	18.1	91	52-147	
Bromochloromethane	ug/L	ND	20	17.5	87	72-128	
Bromodichloromethane	ug/L	ND	20	18.6	93	65-137	
Bromoform	ug/L	ND	20	19.2	96	59-133	
Bromomethane	ug/L	ND	20	24.4	122	30-150	
Carbon disulfide	ug/L	ND	20	17.7	89	30-150	
Carbon tetrachloride	ug/L	ND	20	20.2	101	73-144	
Chlorobenzene	ug/L	ND	20	17.9	89	75-126	
Chloroethane	ug/L	ND	20	21.3	106	55-150	
Chloroform	ug/L	ND	20	17.2	86	66-143	
Chloromethane	ug/L	ND	20	22.1	110	42-150	
cis-1,2-Dichloroethene	ug/L	0.78J	20	18.1	87	65-143	
cis-1,3-Dichloropropene	ug/L	ND	20	17.9	89	75-125	
Dibromochloromethane	ug/L	ND	20	18.9	95	75-125	
Dibromomethane	ug/L	ND	20	19.0	95	66-133	
Dichlorodifluoromethane	ug/L	ND	20	24.1	121	74-150	
Ethylbenzene	ug/L	ND	20	18.3	91	67-149	
Iodomethane	ug/L	ND	20	19.2	96	30-139	
m&p-Xylene	ug/L	ND	40	38.1	95	69-149	
Methylene Chloride	ug/L	ND	20	18.3	91	67-137	
o-Xylene	ug/L	ND	20	19.4	97	63-150	
Styrene	ug/L	ND	20	20.2	101	75-132	
Tetrachloroethene	ug/L	0.32J	20	17.7	87	73-136	
Toluene	ug/L	ND	20	17.8	89	69-139	
trans-1,2-Dichloroethene	ug/L	ND	20	18.7	93	75-135	
trans-1,3-Dichloropropene	ug/L	ND	20	18.4	92	66-136	
trans-1,4-Dichloro-2-butene	ug/L	ND	50	65.1	130	34-134	CH
Trichloroethene	ug/L	ND	20	18.9	93	74-135	
Trichlorofluoromethane	ug/L	ND	20	24.1	121	75-150	
Vinyl acetate	ug/L	ND	20	12.7	64	30-148	
Vinyl chloride	ug/L	ND	20	21.0	105	69-150	
Xylene (Total)	ug/L	ND	60	57.5	96	70-147	
1,2-Dichloroethane-d4 (S)	%.				101	75-125	
4-Bromofluorobenzene (S)	%.				98	75-125	
Toluene-d8 (S)	%.				98	75-125	

SAMPLE DUPLICATE: 2371587

Parameter	Units	10361997001 Result	Dup Result	RPD	Max RPD	Qualifiers
1,1,1,2-Tetrachloroethane	ug/L	ND	ND		30	
1,1,1-Trichloroethane	ug/L	ND	ND		30	
1,1,2,2-Tetrachloroethane	ug/L	ND	ND		30	
1,1,2-Trichloroethane	ug/L	ND	ND		30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

SAMPLE DUPLICATE: 2371587

Parameter	Units	10361997001 Result	Dup Result	RPD	Max RPD	Qualifiers
1,1-Dichloroethane	ug/L	ND	ND		30	
1,1-Dichloroethene	ug/L	ND	ND		30	
1,2,3-Trichloropropane	ug/L	ND	ND		30	
1,2-Dibromo-3-chloropropane	ug/L	ND	ND		30	
1,2-Dibromoethane (EDB)	ug/L	ND	ND		30	
1,2-Dichlorobenzene	ug/L	ND	ND		30	
1,2-Dichloroethane	ug/L	ND	ND		30	
1,2-Dichloropropane	ug/L	ND	ND		30	
1,4-Dichlorobenzene	ug/L	ND	ND		30	
2-Butanone (MEK)	ug/L	ND	ND		30	
2-Hexanone	ug/L	ND	ND		30	
4-Methyl-2-pentanone (MIBK)	ug/L	ND	ND		30	
Acetone	ug/L	ND	ND		30	
Acrylonitrile	ug/L	ND	ND		30	
Benzene	ug/L	ND	ND		30	
Bromochloromethane	ug/L	ND	ND		30	
Bromodichloromethane	ug/L	ND	ND		30	
Bromoform	ug/L	ND	ND		30	
Bromomethane	ug/L	ND	ND		30	
Carbon disulfide	ug/L	ND	ND		30	
Carbon tetrachloride	ug/L	ND	ND		30	
Chlorobenzene	ug/L	ND	ND		30	
Chloroethane	ug/L	ND	ND		30	
Chloroform	ug/L	0.23J	0.28J		30	
Chloromethane	ug/L	ND	ND		30	
cis-1,2-Dichloroethene	ug/L	ND	ND		30	
cis-1,3-Dichloropropene	ug/L	ND	ND		30	
Dibromochloromethane	ug/L	ND	ND		30	
Dibromomethane	ug/L	ND	ND		30	
Dichlorodifluoromethane	ug/L	ND	ND		30	
Ethylbenzene	ug/L	ND	ND		30	
Iodomethane	ug/L	ND	ND		30	
m&p-Xylene	ug/L	ND	ND		30	
Methylene Chloride	ug/L	ND	ND		30	
o-Xylene	ug/L	ND	ND		30	
Styrene	ug/L	ND	ND		30	
Tetrachloroethene	ug/L	ND	ND		30	
Toluene	ug/L	ND	ND		30	
trans-1,2-Dichloroethene	ug/L	ND	ND		30	
trans-1,3-Dichloropropene	ug/L	ND	ND		30	
trans-1,4-Dichloro-2-butene	ug/L	ND	ND		30	
Trichloroethene	ug/L	ND	ND		30	
Trichlorofluoromethane	ug/L	ND	ND		30	
Vinyl acetate	ug/L	ND	ND		30	
Vinyl chloride	ug/L	ND	ND		30	
Xylene (Total)	ug/L	ND	ND		30	
1,2-Dichloroethane-d4 (S)	%.	111	114	3		

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

SAMPLE DUPLICATE: 2371587

Parameter	Units	10361997001 Result	Dup Result	RPD	Max RPD	Qualifiers
4-Bromofluorobenzene (S)	%.	94	96	2		
Toluene-d8 (S)	%.	101	99	2		

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

QC Batch: 437137
Analysis Method: EPA 120.1
QC Batch Method: EPA 120.1
Analysis Description: 120.1 Specific Conductance
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004

METHOD BLANK: 2374936
Matrix: Water
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Specific Conductance	umhos/cm	ND	1.0	1.0	09/23/16 15:11	

LABORATORY CONTROL SAMPLE: 2374937

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Specific Conductance	umhos/cm	1000	966	97	90-110	

SAMPLE DUPLICATE: 2375968

Parameter	Units	10363355001 Result	Dup Result	RPD	Max RPD	Qualifiers
Specific Conductance	umhos/cm	216	211	2	20	

SAMPLE DUPLICATE: 2375969

Parameter	Units	10362179004 Result	Dup Result	RPD	Max RPD	Qualifiers
Specific Conductance	umhos/cm	3900	3930	1	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

QC Batch: 435592
QC Batch Method: SM 4500-H+B
Analysis Method: SM 4500-H+B
Analysis Description: 4500H+B pH
Associated Lab Samples: 10361997001, 10361997002, 10361997003

LABORATORY CONTROL SAMPLE: 2367369

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
pH at 25 Degrees C	Std. Units	5	5.0	100	98-102	H6

SAMPLE DUPLICATE: 2367370

Parameter	Units	10362261001 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	8.5	8.5	0	3	H6

SAMPLE DUPLICATE: 2367371

Parameter	Units	10361883004 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	6.4	6.4	0	3	H6

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

QC Batch: 437136
QC Batch Method: SM 4500-H+B
Analysis Method: SM 4500-H+B
Analysis Description: 4500H+B pH
Associated Lab Samples: 10361997004

LABORATORY CONTROL SAMPLE: 2374935

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
pH at 25 Degrees C	Std. Units	5	5.0	100	98-102	H6

SAMPLE DUPLICATE: 2375779

Parameter	Units	10362229007 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	6.8	6.7	0	3	H6

SAMPLE DUPLICATE: 2375780

Parameter	Units	10362179014 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	6.2	6.1	0	3	H6

QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

QC Batch: 435535 Analysis Method: EPA 410.4
QC Batch Method: EPA 410.4 Analysis Description: 410.4 COD
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004

METHOD BLANK: 2367201 Matrix: Water
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Chemical Oxygen Demand	mg/L	ND	50.0	5.4	09/15/16 14:59	

LABORATORY CONTROL SAMPLE: 2367202

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Chemical Oxygen Demand	mg/L	300	312	104	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2367203 2367204

Parameter	Units	10361941001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chemical Oxygen Demand	mg/L	196	250	250	441	445	98	100	90-110	1	20	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2367205 2367206

Parameter	Units	10361942001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chemical Oxygen Demand	mg/L	ND	250	250	270	269	103	103	90-110	0	20	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

QC Batch: 436463
Analysis Method: SM 4500-NO3 H
QC Batch Method: SM 4500-NO3 H
Analysis Description: SM4500NO3-H, NO2 + NO3 pres.
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004

METHOD BLANK: 2371793
Matrix: Water
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Nitrogen, NO2 plus NO3	mg/L	ND	0.10	0.050	09/20/16 13:16	

LABORATORY CONTROL SAMPLE: 2371794

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Nitrogen, NO2 plus NO3	mg/L	2.5	2.5	99	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2371795 2371796

Parameter	Units	10362345004 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, NO2 plus NO3	mg/L	1.7	2.5	2.5	3.8	3.7	84	79	80-120	3	30	M1

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2371797 2371798

Parameter	Units	10362345005 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Nitrogen, NO2 plus NO3	mg/L	1.4	2.5	2.5	3.3	3.5	77	86	80-120	7	30	M1

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QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

QC Batch: 436013 Analysis Method: ASTM D516
QC Batch Method: ASTM D516 Analysis Description: ASTM D516 Sulfate Water
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004

METHOD BLANK: 2369390 Matrix: Water
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Sulfate	mg/L	ND	2.5	1.0	09/16/16 11:07	

LABORATORY CONTROL SAMPLE & LCSD: 2369391 2369392

Parameter	Units	Spike Conc.	LCS Result	LCSD Result	LCS % Rec	LCSD % Rec	% Rec Limits	RPD	Max RPD	Qualifiers
Sulfate	mg/L	7.5	7.7	7.9	103	105	80-120	2	20	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2369393 2369394

Parameter	Units	10362320001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Sulfate	mg/L	5.9	20	20	26.2	26.4	101	102	80-120	1	30	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2369395 2369396

Parameter	Units	10361997001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Sulfate	mg/L	184	20	20	202	198	90	72	80-120	2	30	M6

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: OLD LANDFILL
Pace Project No.: 10361997

QC Batch: 435779
QC Batch Method: SM 4500-Cl E
Analysis Method: SM 4500-Cl E
Analysis Description: SM4500Cl-E Chloride
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004

METHOD BLANK: 2368321
Matrix: Water
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Chloride	mg/L	ND	1.0	0.45	09/15/16 10:38	FS

LABORATORY CONTROL SAMPLE: 2368322

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Chloride	mg/L	15	15.0	100	90-110	FS

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2368323 2368324

Parameter	Units	10361996001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	66.9	15	15	82.7	83.4	105	110	80-120	1	30	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2368325 2368326

Parameter	Units	10361996002 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	33.4	15	15	46.3	46.8	86	89	80-120	1	30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project:	OLD LANDFILL
Pace Project No.:	10361997

QC Batch: 436705
Analysis Method: SM 4500-CN-E
QC Batch Method: SM 4500-CN-E
Analysis Description: SM4500CN-E Cyanide
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004

METHOD BLANK: 2372950
Matrix: Water
Associated Lab Samples: 10361997001, 10361997002, 10361997003, 10361997004

Parameter	Units	Blank Result	Reporting Limit	MDL	Analyzed	Qualifiers
Cyanide	ug/L	ND	10.0	4.2	09/21/16 16:05	

LABORATORY CONTROL SAMPLE: 2372951

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Cyanide	ug/L	250	273	109	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2372952 2372953

Parameter	Units	10362341001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Cyanide	ug/L	ND	250	250	266	267	106	106	80-120	0	30	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 2372954 2372955

Parameter	Units	10362343001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Cyanide	ug/L	ND	250	250	278	263	111	105	80-120	6	30	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALIFIERS

Project:	OLD LANDFILL
Pace Project No.:	10361997

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.
ND - Not Detected at or above adjusted reporting limit.
J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.
MDL - Adjusted Method Detection Limit.
PQL - Practical Quantitation Limit.
RL - Reporting Limit.
S - Surrogate
1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.
Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.
LCS(D) - Laboratory Control Sample (Duplicate)
MS(D) - Matrix Spike (Duplicate)
DUP - Sample Duplicate
RPD - Relative Percent Difference
NC - Not Calculable.
SG - Silica Gel - Clean-Up
U - Indicates the compound was analyzed for, but not detected.
N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.
Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.
TNI - The NELAC Institute.

LABORATORIES

PASI-M	Pace Analytical Services - Minneapolis

ANALYTE QUALIFIERS

B	Analyte was detected in the associated method blank.
CH	The continuing calibration for this compound is outside of Pace Analytical acceptance limits. The results may be biased high.
FS	The sample was filtered in the laboratory prior to analysis.
H6	Analysis initiated outside of the 15 minute EPA required holding time.
L0	Analyte recovery in the laboratory control sample (LCS) was outside QC limits.
L3	Analyte recovery in the laboratory control sample (LCS) exceeded QC limits. Analyte presence below reporting limits in associated samples. Results unaffected by high bias.
M1	Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.
M6	Matrix spike and Matrix spike duplicate recovery not evaluated against control limits due to sample dilution.

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: OLD LANDFILL
Pace Project No.: 10361997

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
10361997001	BSB-GW-01-090716	EPA 3020	436255	EPA 6020A	436560
10361997001	BSB-GW-01-090716	EPA 8260B	436367		
10361997002	BSB-GW-02-090716	EPA 8260B	436367		
10361997003	BSB-GW-03-090716	EPA 8260B	436367		
10361997004	BSB-GW-04-090716	EPA 8260B	436367		
10361997005	BSB-GW-07-090716	EPA 8260B	436367		
10361997006	Trip Blank	EPA 8260B	436367		
10361997001	BSB-GW-01-090716	EPA 120.1	437137		
10361997002	BSB-GW-02-090716	EPA 120.1	437137		
10361997003	BSB-GW-03-090716	EPA 120.1	437137		
10361997004	BSB-GW-04-090716	EPA 120.1	437137		
10361997001	BSB-GW-01-090716	SM 4500-H+B	435592		
10361997002	BSB-GW-02-090716	SM 4500-H+B	435592		
10361997003	BSB-GW-03-090716	SM 4500-H+B	435592		
10361997004	BSB-GW-04-090716	SM 4500-H+B	437136		
10361997001	BSB-GW-01-090716	EPA 410.4	435535	EPA 410.4	435876
10361997002	BSB-GW-02-090716	EPA 410.4	435535	EPA 410.4	435876
10361997003	BSB-GW-03-090716	EPA 410.4	435535	EPA 410.4	435876
10361997004	BSB-GW-04-090716	EPA 410.4	435535	EPA 410.4	435876
10361997001	BSB-GW-01-090716	SM 4500-NO3 H	436463		
10361997002	BSB-GW-02-090716	SM 4500-NO3 H	436463		
10361997003	BSB-GW-03-090716	SM 4500-NO3 H	436463		
10361997004	BSB-GW-04-090716	SM 4500-NO3 H	436463		
10361997001	BSB-GW-01-090716	ASTM D516	436013		
10361997002	BSB-GW-02-090716	ASTM D516	436013		
10361997003	BSB-GW-03-090716	ASTM D516	436013		
10361997004	BSB-GW-04-090716	ASTM D516	436013		
10361997001	BSB-GW-01-090716	SM 4500-Cl E	435779		
10361997002	BSB-GW-02-090716	SM 4500-Cl E	435779		
10361997003	BSB-GW-03-090716	SM 4500-Cl E	435779		
10361997004	BSB-GW-04-090716	SM 4500-Cl E	435779		
10361997001	BSB-GW-01-090716	SM 4500-CN-E	436705	SM 4500-CN-E	436759
10361997002	BSB-GW-02-090716	SM 4500-CN-E	436705	SM 4500-CN-E	436759
10361997003	BSB-GW-03-090716	SM 4500-CN-E	436705	SM 4500-CN-E	436759
10361997004	BSB-GW-04-090716	SM 4500-CN-E	436705	SM 4500-CN-E	436759

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CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

10361997

Page: 1 of 1

Section A
Required Client Information:

Company: Pioneer Technical
Address: 40 Spanish Peak Dr.
Bozeman, MT 59718
Email To: jemmert@pioneer-techinical.com
Phone: 406-782-5177 Fax:
Requested Due Date/TAT: Standard

Section B
Required Project Information:

Report To: J.D. Emmert
Copy To: Vanessa Armstrong, varmstrong@pioneer-technical
Purchase Order No.:
Project Name: OLD LANDFILL
Project Number:

Section C
Invoice Information:

Attention: ~~Gary Keeler~~ (406-497-6515) Dave Schultz
Company Name: BSB Public Works Dept
Address: 126 W. Granite Butte,MT 59701
Pace Quote Reference:
Pace Project Manager: Julie Bowser
Pace Profile #: 22208

REGULATORY AGENCY

☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER
☐ UST ☐ RCRA ☐ OTHER ______

Site Location STATE: MT

Section D
Required Client Information

Valid Matrix Codes

MATRIX	CODE
DRINKING WATER	DW
WATER	WT
WASTE WATER	WW
PRODUCT	P
SOIL/SOLID	SL
OIL	OL
WIPE	WP
AIR	AR
OTHER	OT
TISSUE	TS

Requested Analysis Filtered (Y/N)

ITEM #	SAMPLE ID (A-Z, 0-9 / ,-) Sample IDs MUST BE UNIQUE	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED COMPOSITE START DATE	COMPOSITE START TIME	COMPOSITE END/GRAB DATE	COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Preservatives Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test Y/N	Cyanide	Nitrate+Nitrite	COD	pH, SC, SO4 and Chloride	8260	Dissolved Metals*	Sulfide	Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1	BSB-GW-01-	WT		9/7/16	~~[illegible]~~	1055			7										x	x	x	x	x	x			001
2	BSB-GW-02-	WT				1225			6										x	x	x	x	x				002
3	BSB-GW-03-	WT				1255			6										x	x	x	x	x				003
4	BSB-GW-04-	WT				1425			6										x	x	x	x	x				004
5	BSB-GW-07-	WT				1440			3														x				005
6	Trip Blank	WT							2														x				006
7																											
8																											
9																											
10																											
11																											
12																											

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS			
*Sb, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Ni, Se, V, Zn	Brad Hollaman	9/8/16	12:00	Pace	9-10-16	9:45	1.5	Y	Y	Y
							Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)

SAMPLER NAME AND SIGNATURE
PRINT Name of SAMPLER: Brad Hollamon
SIGNATURE of SAMPLER: Brad Hollaman
DATE Signed (MM/DD/YY): 9/8/16

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.

F-ALL-Q-020rev.07, 15-Feb-2007

Pace Analytical®	Document Name: **Sample Condition Upon Receipt Form**	Document Revised: 02Aug2016 Page 1 of 2
	Document No.: **F-MN-L-213-rev.17**	Issuing Authority: Pace Minnesota Quality Office

Sample Condition Upon Receipt

Client Name: Pioneer Tech

Project #:

WO#: 10361997

10361997

Courier: ☑ Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☐ Pace ☐ SpeeDee ☐ Other:

Tracking Number: 6751 5499 2485

Optional: Proj. Due Date: Proj. Name:

Custody Seal on Cooler/Box Present? ☑ Yes ☐ No **Seals Intact?** ☑ Yes ☐ No

Packing Material: ☑ Bubble Wrap ☐ Bubble Bags ☐ None ☐ Other:

Temp Blank? ☑ Yes ☐ No

Thermometer Used: ☑ 151401163 ☐ 151401164 ☐ B88A912167504 ☐ B88A0143310098

Type of Ice: ☑ Wet ☐ Blue ☐ None ☐ Samples on ice, cooling process has begun

Cooler Temp Read (°C): 1.6 **Cooler Temp Corrected (°C):** 1.5 **Biological Tissue Frozen?** ☐ Yes ☐ No ☑ N/A

Temp should be above freezing to 6°C **Correction Factor:** -0.1 **Date and Initials of Person Examining Contents:** KAC 9-10-16

USDA Regulated Soil (☑ N/A, water sample)

Did samples originate in a quarantine zone within the United States: AL, AR, AZ, CA, FL, GA, ID, LA, MS, NC, NM, NY, OK, OR, SC, TN, TX or VA (check maps)? ☐ Yes ☐ No

Did samples originate from a foreign source (internationally, including Hawaii and Puerto Rico)? ☐ Yes ☐ No

If Yes to either question, fill out a Regulated Soil Checklist (F-MN-Q-338) and include with SCUR/COC paperwork.

				COMMENTS:
Chain of Custody Present?	☑ Yes	☐ No	☐ N/A	1.
Chain of Custody Filled Out?	☑ Yes	☐ No	☐ N/A	2.
Chain of Custody Relinquished?	☑ Yes	☐ No	☐ N/A	3.
Sampler Name and/or Signature on COC?	☑ Yes	☐ No	☐ N/A	4.
Samples Arrived within Hold Time?	☑ Yes	☐ No	☐ N/A	5.
Short Hold Time Analysis (<72 hr)?	☐ Yes	☑ No	☐ N/A	6.
Rush Turn Around Time Requested?	☐ Yes	☑ No	☐ N/A	7.
Sufficient Volume?	☑ Yes	☐ No	☐ N/A	8.
Correct Containers Used?	☑ Yes	☐ No	☐ N/A	9.
-Pace Containers Used?	☑ Yes	☐ No	☐ N/A	
Containers Intact?	☑ Yes	☐ No	☐ N/A	10.
Filtered Volume Received for Dissolved Tests?	☑ Yes	☐ No	☐ N/A	11. Note if sediment is visible in the dissolved container
Sample Labels Match COC? -Includes Date/Time/ID/Analysis Matrix: WT	☑ Yes	☐ No	☐ N/A	12.
All containers needing acid/base preservation have been checked?	☑ Yes	☐ No	☐ N/A	13. ☑ HNO_3 ☑ H_2SO_4 ☑ NaOH ☐ HCl Sample # 1: 1 1/1 1/1 1-4:
All containers needing preservation are found to be in compliance with EPA recommendation? (HNO_3, H_2SO_4, HCl<2; NaOH >9 Sulfide, NaOH>12 Cyanide)	☑ Yes	☐ No	☐ N/A	
Exceptions: VOA, Coliform, TOC, Oil and Grease, DRO/8015 (water) DOC	☑ Yes	☐ No	☐ N/A	Initial when completed: Lot # of added preservative:
Headspace in VOA Vials (>6mm)?	☐ Yes	☑ No	☐ N/A	14.
Trip Blank Present?	☑ Yes	☐ No	☐ N/A	15.
Trip Blank Custody Seals Present?	☑ Yes	☐ No	☐ N/A	
Pace Trip Blank Lot # (if purchased): 95314				

CLIENT NOTIFICATION/RESOLUTION **Field Data Required?** ☐ Yes ☐ No

Person Contacted: Date/Time:

Comments/Resolution: verified with Brad that sample ID's should have date of collection after them

Project Manager Review: **Date:** 9/11/16

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers).

County Butte-Silver Bow
Facility & # 20
Closure
Finan Assur
[✓ GW Corr Meas]
GW Monitoring
GW Reports
Inspections
Other: ____
Landfarm
Liner
Methane
O & M
Run-on

County Silver Bow
Facility & # 20
Closure
Finan Assur
[✓ GW Corr Meas]
GW Monitoring
GW Reports
Inspections
Other: ____
Landfarm
Liner
Methane
O & M
Run-on

2/7/15 mdm

PIONEER
TECHNICAL SERVICES, INC.

January 30, 2015

PT

RECEIVED

FEB 05 2015

Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

John Collins
Environmental Science Specialist
Solid Waste Program
Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901

RE: Closed Butte-Silver Bow County Landfill – License #20
Effectiveness of Implemented Corrective Measures

Dear Mr. Collins:

Attached is a report regarding the effectiveness of the previously implemented corrective measures at the Old Butte-Silver Bow County Landfill. This report is submitted on behalf of the Butte-Silver Bow local government, in accordance with your October 14, 2014, letter to Dave Schultz, Director of Public Works.

As noted in your letter, this report analyzes the effectiveness of the corrective measures in accordance with the requirements of the Administrative Rules of Montana Title 17, Chapter 50, Subchapter 13. You initially indicated that this report was due to the Department by December 31, 2014; however, you extended that deadline to January 31, 2015, in a subsequent email.

Should you have any questions or comments on this report, please direct them to Dave Schultz at (406) 497-6519, or me at (406) 782-5177. We look forward to hearing from you.

Sincerely,

Mitch Mihailovich

Mitch Mihailovich
Project Engineer

Cc:

Dave Shultz/BSB – electronic copy
Loren Burmeister/Atlantic Richfield Company – electronic copy
Cord Harris/Atlantic Richfield Company – w/o enclosure – email
Irene Montero/Atlantic Richfield Company – w/o enclosure – email
Ann Baranowski/Atlantic Richfield Company (Central Files 70.04.25.16) – electronic copy

Collins, John

From: Collins, John
Sent: Tuesday, December 23, 2014 8:06 AM
To: 'Bill Henne'
Subject: RE: Closed Butte-Silver Bow County Landfill - License #20, 5-year evaluation extension

Hello Bill,

The extension requested is approved. I will look forward to the five year review submittal by January 31, 2015.

Thank you,

John

John Collins, CHMM
Hydrogeologist
Solid Waste section
Montana Department of Environmental Quality
Phone: 406.444.2802
jcollins3@mt.gov

From: Bill Henne [mailto:bhenne@pioneer-technical.com]
Sent: Monday, December 22, 2014 4:50 PM
To: Collins, John
Cc: Mitch Mihailovich; Brad Archibald; Mike Borduin
Subject: Closed Butte-Silver Bow County Landfill - License #20, 5-year evaluation extension

Good evening Mr. Collins,

Thank you for taking the time to speak with me earlier in regards to an extension on the 5-year evaluation that is due to the Department of Environmental Quality, Solid Waste Program, by December 31, 2014.

Per our discussion, Pioneer Technical Services is requesting a one month extension (due date January 31, 2015) to finalize the 5-year evaluation, present it to our clients, followed by submittal to your department for review.

At your convenience, please let me know if this is acceptable.

Thank you for your time and please do not hesitate to let me know if there is anything you need from this end.

Happy holidays,

-bill

Bill Henne, EI
Project Engineer

PIONEER
TECHNICAL SERVICES, INC.
406.782.5177 – office
406.497.8052 – direct
406.565.6567 – cell
bhenne@pioneer-technical.com

DRAFT
EVALUATION OF THE EFFECTIVENESS OF THE CORRECTIVE MEASURES AT THE OLD SILVER BOW LANDFILL/ CLARK TAILINGS

RECEIVED

APR 29 2009

Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

PIONEER
TECHNICAL SERVICES, INC.
P.O. BOX 3445, BUTTE, MONTANA 59702 PHONE (406) 782-5177 FAX (406) 782-5866
100% post-consumer paper & 100% vegetable based inks

DRAFT
EVALUATION OF THE EFFECTIVENESS OF THE CORRECTIVE MEASURES AT THE OLD SILVER BOW LANDFILL/ CLARK TAILINGS

Prepared for:

City and County of Butte-Silver Bow
Department of Public Works
126 W. Granite Street
Butte, MT 59701

Prepared by:

Pioneer Technical Services, Inc.
P.O. Box 3445
Butte, Montana 59701

April 29, 2009

PIONEER
TECHNICAL SERVICES, INC.

P.O Box 3445, Butte, MT 59702
www.pioneer-technical.com

April 28, 2009

Martin Van Oort
Environmental Science Specialist
Solid Waste Program
Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901

RE: Closed Butte-Silver Bow County Landfill – License #20
Effectiveness of Implemented Corrective Measures

Dear Mr. Van Oort:

Attached is a report regarding the effectiveness of the previously implemented corrective measures at the Old Butte-Silver Bow County Landfill. This report is submitted on behalf of the Butte-Silver Bow local government, in accordance with your December 16, 2008 letter to Gary Keeler, Manager of the Butte-Silver Bow Landfill.

As noted in your letter, this report analyzes the effectiveness of the corrective measures in accordance with the requirements of the Administrative Rules of Montana (ARM) 17.50.710(7)(b). You initially indicated that this report was due to the Department on April 16, 2009, but in a subsequent email from you, that deadline was extended to April 29, 2009.

Should you have any questions or comments on the report, please direct them to Gary Keeler at (406) 497-6515, or me at (406) 563-9371. We look forward to hearing from you.

Sincerely,

Brad Archibald for

Shawn Bisch
Principal Engineer

cc:

Dan Dennehy, BSB (w/out attachment)
Shannon Dunlap, Atlantic Richfield Company
Gary Keeler, BSB
Rick Larson, BSB

RECEIVED
APR 29 2009
Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

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Billings, MT 59102
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Fax (406) 545-4658

HELENA
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Helena, MT 59601
Phone (406) 457-8252
Fax (406) 442-1158

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1.0 INTRODUCTION

Because of the presence of certain constituents of concern (COCs) at concentrations exceeding groundwater protection standards listed in Table 2 of the Administrative Rules of Montana Title 17, Chapter 50.7.708, a Corrective Measures Assessment (CMA) of the Old Butte-Silver Bow Landfill/Clark Tailings was completed in 1997. The preferred alternative identified in the CMA was capping of the landfill and adjacent Clark Tailings and passive venting of landfill gas. The CMA was approved by Montana Department of Environmental Quality (DEQ) on March 21, 1997.

The corrective measures identified in the preferred alternative were implemented at the site. The landfill was capped and a passive landfill gas venting system was installed in 1997. On the Clark Tailings portion of the site, wastes from Lower Area One (LAO) of the Butte Priority Soils Operable Unit (BPSOU) were consolidated with the Clark Tailings, and the cap in accordance with CMA was completed in 1998. As contemplated in the CMA, a park complex was constructed on the site (the Copper Mountain Sports and Recreation Complex) and was opened in 2001 (Figure 1).

As part of the corrective measures, a controlled groundwater area (CGA) was established through the Montana Department of Natural Resources. This CGA includes the waste management areas and downgradient area that was determined to potentially be impacted by the development of groundwater (Figure 2).

Since groundwater protection standards (GWPS) exceedances were first documented, assessment monitoring of groundwater has been conducted semi-annually at the site. As of the fall of 2008, certain COCs still exceed GWPS. Therefore, in the December 16, 2008 letter to Gary Keeler, Manager of the Butte-Silver Bow Landfill, the DEQ directed Butte-Silver Bow to submit a report summarizing the effectiveness of the current corrective measures. This report has been prepared in accordance with that directive.

1. Objectives of Corrective Measures.

   The objectives of the corrective measures were to meet the requirements of ARM 17.50.710(7)(b), which requires that, "Remedies must:

   (i) Be protective of human health and the environment;
   (ii) Attain the ground water protection standard as specified pursuant to (5) of this rule;
   (iii) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent practicable, further releases of Table 2 [ARM 17.50.708] constituents into the environment that may pose a threat to human health or the environment; and
   (iv) Comply with standards for management of wastes as specified in (8) of this rule.
   (v) Be approved by the department."

   The CMA developed and evaluated alternatives and selected a preferred remedy based on its anticipated ability to meet these requirements.

2.0 SUMMARY OF CORRECTIVE MEASURES

2.1 ALTERNATIVES CONSIDERED

The following alternatives were considered during the corrective measures assessment process (Pioneer, 1997):

- Alternative 1: No Action;
- Alternative 2: Institutional Controls;
- Alternative 3: Native Materials Capping;
- Alternative 4: Native Materials Capping with Institutional Controls;
- Alternative 5: Low Permeability Capping with Institutional Controls;
- Alternative 6: Multimedia Capping with Institutional Controls;
- Alternative 7: Vertical Groundwater Barriers with Capping and Institutional Controls;
- Alternative 8: Passive Gas Removal with Capping and Institutional Controls;
- Alternative 9: Groundwater Removal and Treatment with Capping and Institutional Controls; and
- Alternative 10: *In-Situ* Groundwater Treatment with Capping and Institutional Controls.

2.2 PREFERRED ALTERNATIVE

Alternative 8, Passive Gas Removal with Capping and Institutional Controls was identified as the preferred alternative and approved by DEQ Permitting and Compliance Division, Solid Waste Program on March 21, 1997. The alternative called for a native materials cap to be installed over the landfill portion of the site, and installing a low permeability cap over the Clark Tailings. Groundwater use restrictions through a designated CGA and land use restrictions would be implemented. Passive gas vents would be installed over a portion of the landfill. The preferred alternative included potential development of the capped site as a recreational complex.

2.3 SUMMARY OF COMPLETED ACTIVITIES

2.3.1 Landfill

The balance of the Old Butte-Silver Bow Landfill was closed in accordance with the Interim Closure Plan for the Butte-Silver Bow Landfill under the Solid Waste Program regulations in effect prior to October 9, 1991 (SRM, 1993). Approximately 4 acres of the landfill continued to receive waste after October, 9, 1991. These 4 acres were closed under the preferred alternative described in the CMA (Pioneer, 1997). The following actions were completed during the closure activities:

- Cover soil installation began on May 22, 1997 and was completed on June 25, 1997 with the placement of a minimum of 24 inches of cover soil including an infiltration barrier; and

- A passive landfill gas venting system was installed in June 1997.

2.3.2 Clark Tailings

The construction work to complete the corrective action at the Clark Tailings Consolidated Waste Management Area was completed in September 1998 and consisted of the following:

- Mine wastes from LAO and surficial tailings and impacted soils from the perimeter of the Clark Tailings Consolidated Waste Management Area (WMA) were hauled and placed in the Clark Tailings Consolidated WMA. The placement of approximately 836,858 cubic yards of mine wastes began at the end of March 1997 and was completed June 1998.
- A French drain was constructed on the north slope of the Clark Tailings Consolidated WMA to drain a minor seepage that developed during construction activities.
- A drainage system around the perimeter of the Clark Tailings Consolidated WMA consisting of a collection ditch system and two collection ponds was completed. Ditch segments identified as Type I (transport water over a tailings impacted subgrade) are lined with a geosynthetic clay liner (GCL) for infiltration control. The Type II ditches (designed to carry water over a clean subgrade) did not require lining. The South Pond is located at the south end of the disposal area and functions as a settling pond and water storage for runoff from the Timber Butte area south of the site. The Timber Butte pond is located at the northeast corner of the Clark Tailings Consolidated WMA and functions as a settling pond for water collected and transported by the ditches around the perimeter of the disposal area. Both ponds were lined with GCL. Drainage system work commenced on April 6, 2008 and was completed the week of September 21, 2008.

The cover system for the Clark Tailings Consolidated WMA consisting of approximately 40 inches of material was placed on top of the compacted tailings subgrade material. The cap was constructed of 18 inches of low permeability, infiltration barrier material, 4.5 inches of capillary break gravel, 1 geotextile filter fabric, 12 inches of general fill and 6 inches of topsoil growth media.

2.3.3 Copper Mountain Sports and Recreation Complex

Improvements to the site to create the Copper Mountain Sports and Recreation Complex were completed in 2001, when the park was opened. These improvements included utilities; a 3,600-square foot concession building; baseball and softball fields; playground area; trails and parking areas; and irrigation and landscaping improvements. The DEQ provided guidance on how to irrigate the complex (Appendix A).

2.4 RESPONSE TIME ESTIMATES

Since the volatile organic compounds (VOC) and divalent metals were expected to respond differently to the corrective measures, the CMA evaluated the likely response in groundwater for each type of COC separately. Since the Old Landfill was considered the likely source of the VOCs, their point of compliance was determined to be Wells BSB-A6R, BSB-A5, and BSB-A1. As summarized in Section 9 of the CMA (Pioneer, 1997), it would take an estimated 4.7 years to complete a single flush of the VOC contaminated aquifer; it also estimated that up to 5 flushes (approximately 23 years) may be needed to comply with the GWPS. This estimate is very sensitive to the aquifer's hydraulic conductivity estimate of 1.0E-03 centimeters per second (cm/sec); if the actual hydraulic conductivity of the heterogeneous aquifer is lower, it could take significantly longer to achieve GWPS. Estimates from the March 2009 sampling event, using a technique described by Robbins, et al (2009) indicate that the hydraulic conductivity of in wells BSB-A1 and BSB-A6R are less than 1.0E-03 cm/sec (Appendix B).

The point of compliance wells for inorganic COCs are Wells CLK-1 and CLK-2, downgradient of the Clark Tailings. Calculations in Appendix G of the CMA (Pioneer, 1997) estimated that it would take 3.7 years for water in the Clark Tailings to drain to the underlying aquifer and 12.4 years to complete a flush of the aquifer beneath the Clark Tailings. It would not be until this time that one would see improvements in the downstream wells. The CMA considered that the source of zinc in CLK-1 may be the more localized tailings immediately above CLK-1 in the Timber Butte Sedimentation Basin (which was lined with a GCL as part of the corrective measures), and therefore, improvements in water quality in CLK-1 may be observed in 6.7 years after the capping.

As reported in Appendix D of the CMA (Pioneer, 1997) of the CMA, Hydrologic Evaluation of Landfill Performance (HELP) Modeling Results, there remains some percolation from the landfill and Clark Tailings waste materials into the underlying aquifer. This fact may extend the time until results are observed in the monitoring wells.

3.0 EVALUATION OF EFFECTIVENESS OF THE CORRECTIVE MEASURES

The effectiveness of the corrective measures at the Old Butte Landfill/Clark Tailings site at meeting each of the requirements of listed at ARM 17.50.710(7)(b) is evaluated in this section.

a. "Be protective of human health and the environment":

    The corrective measures have been and continue to be protective of human health and the environment. Capping of the landfill and Clark Tailings has removed any potential direct exposure to human or environmental receptors to the waste; on-going inspections assure that integrity of the caps is maintained.

    Downgradient monitoring of groundwater conducted during the CMA indicated that COCs had not caused any exceedances of GWPS downgradient of the site.

    To further protect human health and the environment, a CGA was instituted, through the Montana Department of Natural Resources and Conservation, to limit future development of groundwater downgradient of the site. That CGA is described by the DNRC in their publication posted at http://dnrc.mt.gov/wrd/water_rts/appro_info/basinclose-cgw_areas.pdf and depicted on Figure 2.

    In addition to the existing CGA, a new CGA associated with Butte Mine Flooding Operable Unit, BPSOU and Montana Pole Treating Plant Superfund sites is in the process of being established. The petition has been filed with the Department of Natural Resources and Conservation, and a public hearing is scheduled for May 11, 2009. More information is available at http://dnrc.mt.gov/wrd/water_rts/cgwa/butte/default.asp. This site will be continuous with the Old Butte Landfill/Clark Tailings CGA (see Figure 3). The premise for the BPSOU portion of this CGA is the conclusion that it is technically impracticable to attain groundwater standards in the Butte area alluvial aquifer where saturated mine wastes are present, as explained in the BPSOU Record of Decision (ROD) (U.S. Environmental Protection Agency Record of Decision Butte Priority Soils Operable Unit Silver Bow Creek/Butte Area NPL Site, September 2006, http://epa.gov/region8/superfund/mt/sbcbutte/Section12.pdf, p. 12-32). As noted in the ROD (p. 12-32), "groundwater contamination within the alluvial aquifer is expected to exceed (standards) for the long-term and because statutory and regulatory conditions for a technical impracticability waiver are met, applicable groundwater (standards) have been waived for the alluvial aquifer within the boundary of the technical impracticability (TI) zone (Figure 12-6) and wastes will be left in place with appropriate groundwater monitoring and institutional controls."

b. " Attain the groundwater protection standard as specified pursuant to (5) of this rule":

The corrective measures have not yet attained all applicable GWPS, but there is some indication that groundwater quality is improving. The latest groundwater monitoring report is included in Appendix C.

Inorganic constituents are measured in Wells CLK-1 and CLK-2. In Well CLK-1, arsenic and cadmium exceed maximum contaminant levels (MCLs) established by EPA under the Safe Drinking Water Act. In addition, zinc and iron exceed GWPS. However, since 1999 the concentrations of zinc and iron, while still significantly above background, are generally trending downward (Figure 4).

Other inorganic COCs in Well CLK-1 are not following this same trend thus far (Figure 5). Cadmium has steadily increased since the well was installed in 1996, and is now approaching 20 micrograms per Liter (ug/L) (the MCL is 5 ug/L). Arsenic has been above the MCL of 10 ug/L since it was installed, but increased sharply in late 1999 (not long after the Timber Butte Sedimentation Basin above this well was lined). Lead has remained below GWPS and indicates no significant trends.

These trends could be related to the lining of the Timber Butte Sedimentation Basin. Infiltration through the basin may have been dominating water quality prior to lining the basin, and these particular tailings (many of which would have been deposited as storm water related sediment) may have been higher in zinc. After lining, percolation from the bulk of the Clark Tailings themselves could be dominating water quality, and this may be slightly lower in zinc concentrations but higher in the other inorganic COCs.

Sulfate, which may be an indicator of the influence from the Clark Tailings, has also generally declined in Well CLK-1 (Figure 6). It is still well above background concentrations in MBMG-2 (Figure 6).

In Well CLK-2, zinc concentrations (Figure 7) are significantly lower than in CLK-1, but still elevated compared to background. Concentrations in this well (which are below the DEQ-7 human health standard in groundwater of 2,000 ug/L) went up significantly between 2002 and 2003, but have since started to decrease. Other potential COCs in Well CLK-2, while still well below GWPS (based on MCLs), include arsenic and lead. As shown on Figure 8, these COCs are also generally trending downward since 1999, although they are more inconsistent. Cadmium was generally increasing but has since decreased back to original, very low values. Iron in Well CLK-2 (Figure 9) is higher than background but, except for few spikes between 1999 and 2002, is well below the secondary (aesthetic) MCL of 300 ug/L. Sulfate (Figure 10) is higher than background, and appears to be on a slight downward trend since 1999.

For the same reasons that it was concluded as part of the BPSOU that groundwater standards would be exceeded over the long term, it may also be technically impracticable to achieve GWPS in the wells immediately downgradient of the Clark Tailings. The Clark Tailings were originally placed in the Grove Gulch drainage. Grove Gulch continues to run through the toe of the Clark Tailings impoundment in a pre-cast concrete structure constructed by the Soil Conservation Service in the 1980s and the historic Grove Gulch conduit, a wooden flume connected to tailings impoundment dewatering structures, also continues to carry water. (During construction of the Clark Tailings corrective measures, unsuccessful attempts were made to plug the historic Grove Gulch flume.) Therefore, it is likely that a portion of the Clark Tailings is and will continue to be in the saturated zone. While infiltration through the Clark Tailings from above has been mitigated by the installation of the cap and lining the Timber Butte Sedimentation Basin, groundwater inflow from upgradient will continue to saturate a portion of the tailings and mobilize metals into the groundwater. If this is the case, it is unlikely that compliance with GWPS will be achieved in the near future.

Organic COCs are measured in Wells BSB-A1, BSB-A5, and BSB-A6R. In these wells, perchloroethylene (PCE); trichloroethylene (TCE); cis-1,2-dichloroethene (cis-1,2-DCE); and vinyl chloride are primary COCs present. The MCLs for these COCs are as follows:

- PCE : 5 ug/L;
- TCE: 5 ug/L;
- Cis-1,2-DCE: 70 ug/L; and
- Vinyl Chloride: 2 ug/L.

Since 1996, no MCLs for these COCs are exceeded in BSB-A1 or BSB-A5. In BSB-A6R, only vinyl chloride exceeds the MCL. Some other organic COCs have been detected above background concentrations, but none exceed MCLs or DEQ-7 human health standards (HHS) in groundwater. They typically are not present as consistently or at as high of concentrations as the COCs discussed above. Therefore, this evaluation focuses on the four COCs listed above.

In Well BSB-A1, no MCLs are exceeded for any organic COCs. Concentrations of the PCE, TCE; cis-1,2-DCE; and vinyl chloride are shown on Figure 11. In the mid-1990s, PCE was detected in this well at concentrations ranging from 1.6 to 3.3 ug/L (below the MCL of 5 ug/L). Since February 1995, the concentrations of PCE in this well have all been below 1 ug/L, with PCE only being detected once in the 5 samples collected since September 2006. TCE and cis-1,2-DCE concentrations have been below 1 ug/L (and well below their MCLs) over the entire period of record. Vinyl chloride has not been detected in this well.

In Well BSB-A5, there was an exceedance of the PCE MCL in 1996 (Figure 12). Since then, concentrations have been below the MCL, and since 1999 have typically been less than 1 ug/L (1 sample in 2007 was above this, at 1.2 ug/L). The TCE and cis-1,2-DCE have been frequently detected in this well, but at concentrations well below their MCLs. Vinyl chloride has not been detected in this well.

As shown on Figure 13, cis-1,2-DCE and vinyl chloride have been consistently detected in BSB-AR6 since it was installed in 2001. Concentrations have been inconsistent and overall have not decreased since completion of the corrective measures. Vinyl chloride has exceeded its MCL of 2 ug/L since 2002; and cis-1,2-DCE has not exceeded its MCL of 70 ug/L. The concentrations of cis-1,2-DCE and vinyl chloride have been steadily decreasing since the September 2007 sampling event; however, it is too soon to tell if this is a long- or short-term phenomenon. The PCE and TCE concentrations have been consistently below 1 ug/L in this well since it was installed.

The travel time calculations completed as part of the CMA, as described previously, anticipated that it would take 4.7 years to complete a single flush of the potentially contaminated aquifer upgradient of these wells. Landfill gas venting was implemented to prevent further contamination of groundwater by landfill gases carrying VOCs, but the gas venting was not expected to mitigate groundwater contamination already in the aquifer. Therefore, considering the travel time estimates in the CMA, it is not unexpected that concentrations have not been reduced significantly in BSB-A6R. It may take many more years for COCs to attain GWPS in these wells. In the meantime, human health and the environment continue to be protected by the CGA in place downgradient of the site.

c. "Control the source(s) of releases so as to reduce or eliminate, to the maximum extent practicable, further releases of Table 2 [ARM 17.50.708] constituents into the environment that may pose a threat to human health or the environment":

Installation of the caps on the Clark Tailings and Old Landfill has effectively reduced the releases of Table 2 constituents to the maximum extent practicable.

d. "Comply with standards for management of wastes as specified in (8) of this rule":

ARM 17.50.710 (8)(a) states that the owner/operator must:

(i) Establish and implement a corrective action ground water monitoring program that:

(A) at a minimum, meets the requirements of an assessment monitoring program under this rule;
(B) indicates the effectiveness of the corrective action remedy; and

(C) demonstrates compliance with GWPS pursuant to (5) of this rule:"

In accordance with the DEQ-approved Sampling and Analysis Plan, groundwater monitoring at the site that meets these requirements is on-going. The original sampling (starting in 1994) at the Old Landfill was conducted under a SAP prepared by SRM. An updated SAP was incorporated into the CMA report in 1997; this SAP was followed until an updated SAP was submitted to DEQ in April 2007 (Pioneer, 2007) for approval, comments were received in December 2008 and the *Final Butte-Silver Bow Old Landfill Facility Groundwater Sampling and Analysis Plan (SAP)* was submitted in March 2009.

ARM 17.50.710(8)(a)(ii) requires that the corrective action remedy selected as part of the CMA must be implemented.

Construction of the corrective action remedy at the Old Landfill and Clark Tailings was completed in 1998. These activities were documented in construction completion reports for the Clark Tailings (MSE-HKM and Anderson, 1999) and the Landfill (Pioneer, 2006). The construction of the Copper Mountain Sports Complex was completed in 2001.

ARM 17.50.710(8)(a)(iii) requires the owner or operator to, "Take any interim measures necessary to ensure the protection of human health and the environment."

To further protect human health and the environment, a CGA was instituted, through the Montana Department of Natural Resources and Conservation, to limit future development of groundwater downgradient of the site and is depicted on Figure 2. In addition to the existing CGA, a new CGA associated with Butte Mine Flooding Operable Unit, BPSOU and Montana Pole Treating Plant Superfund sites is in the process of being established. The petition has been filed with the Department of Natural Resources and Conservation, and a public hearing is scheduled for May 11, 2009. This site will be continuous with the Old Butte Landfill/Clark Tailings CGA (see Figure 3).

e. "Be approved by the department":

The corrective measures implemented at the site were approved by the DEQ in a March 21, 1997 letter from F. Patrick Crowley to Jack Lynch, BSB Chief Executive.

4.0 SUMMARY AND CONCLUSIONS

The corrective measures remedy was completed at the Old Landfill/Clark Tailings site in 1998. As calculated in the CMA (Pioneer, 1997), it would take an estimated 4.7 years to complete a single flush of the VOC contaminated aquifer below the Old Landfill; it was also estimated that up to 5 flushes (approximately 23 years) may be needed to comply with GWPS. Calculations in the CMA (Appendix G) (Pioneer, 1997) estimated that it would take 3.7 years for water in the Clark Tailings to drain to the underlying aquifer and an additional 12.4 years to complete a flush of the aquifer beneath the Clark Tailings. It would not be until this time that one would see improvements in the downstream wells. This estimate is very sensitive to the aquifer's hydraulic conductivity estimate of 1.0E-03 cm/sec; if the actual hydraulic conductivity of the heterogeneous aquifer is lower, it could take significantly longer to achieve GWPS.

It has been approximately 11 years since the completion of the corrective actions. Although the corrective measures have not yet attained all applicable GWPS (as expected), there is some indication that groundwater quality is improving, although this is not the case for all parameters in all wells. The primary organic COCs do not exceed the MCL-based GWPS in Wells BSB-A1 and BSB-A5, and only vinyl chloride exceeds the MCL in Well BSB-A6R. However, the likely presence of historic mine tailings in the saturated zone may make it technically impracticable to ever achieve all GWPS. Human health and the environment continues to be protected by the capping of the Old Landfill and Clark Tailings which removed any potential direct exposure risk and the implementation of the CGA downgradient of the site.

Assessment monitoring in accordance with the site's groundwater monitoring SAP should continue. A re-evaluation of the effectiveness of the corrective measures should be repeated approximately every 5 to 10 years to determine if there is a trend toward compliance. In this time, the first flush of the aquifer beneath the Clark Tailings should be completed (based on the estimated times in the CMA). If a trend is not apparent, particularly for the inorganic constituents in CLK-1 and/or CLK-2, consideration should be given to concluding that it is not technically practical to meet GWPS, and proceeding in accordance with ARM 17.50.710(8)(c), which states:

(i) *"If the owner or operator determines that compliance with the requirements of (7) (b) of this rule cannot be practically achieved with any currently available methods, the owner or operator must:*
(ii) *Obtain certification of a qualified ground water scientist and approval by the department that compliance with requirements under (7) (b) of this rule cannot be practically achieved with any currently available methods;*
(iii) *Implement alternate measures to control exposure of humans or the environment to residual contamination, as necessary to protect human health and the environment; and*
(iv) *Implement alternate measures for control of the sources of contamination, or for removal or decontamination of equipment, units, devices, or structures that are:*
    (A) Technically practicable; and
    (B) Consistent with the overall objective of the remedy.
(i) *Submit to the department for approval a report justifying the alternative measures 14 days prior to implementing the alternative measures and place a copy of the report in the operating record."*

5.0 REFERENCES

DEQ, 2008. Montana Department of Environmental Quality/Water Quality Bureau. Montana Numeric Water Quality Standards, Circular DEQ-7. February 2008.

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Pioneer, 2007. Draft Butte-Silver Bow Old Landfill Facility Groundwater Sampling and Analysis Plan (SAP).Prepared for Butte-Silver Bow Department of Public Works by Pioneer Technical Services, Inc. April, 2007.

Pioneer, 2006. Construction Quality Assurance Report for the Old Butte-Silver Bow Landfill Final Cover Installation. Prepared for Butte-Silver Bow Department of Public Works by Pioneer Technical Services, Inc. January 2006.

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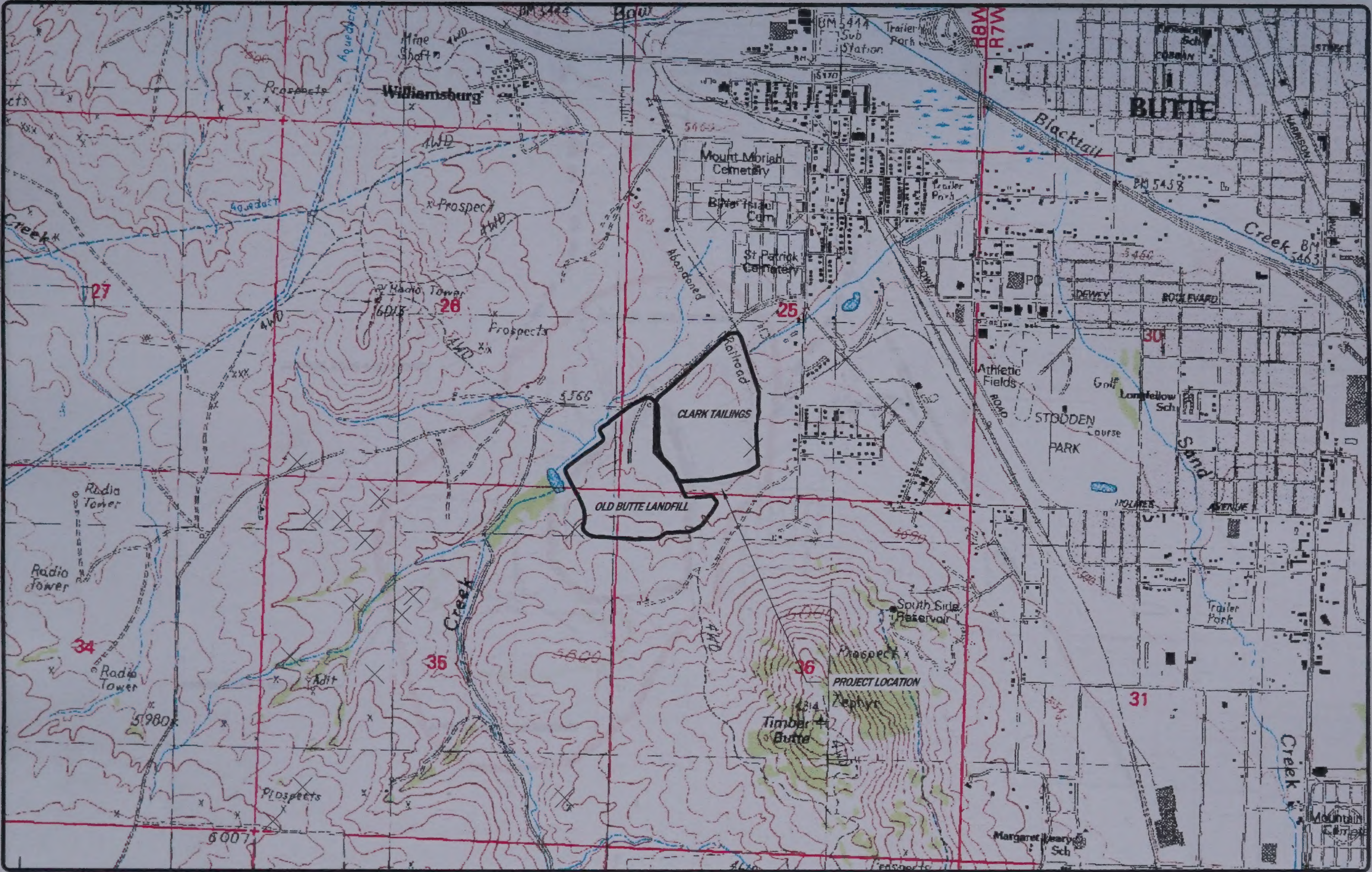
Robbins, G.A., Aragon-Jose, A.T., Romero, A. Determining Hydraulic Conductivity Using Pumping Data from Low-Flow Sampling. Ground Water Volume 47, No. 2. March-April 2009.

SRM, 1993. Interim Closure Plan for the Butte-Silver Bow Landfill.

FIGURES


CLARK TAILINGS
OLD BUTTE LANDFILL
PROJECT LOCATION
BUTTE
Williamsburg
Mount Moriah Cemetery
B'nai Israel Cem
St Patrick Cemetery
Athletic Fields
Golf Course
STODDEN PARK
Longfellow Sch
South Side Reservoir
Timber Butte
Zephyr
Margaret Leary Sch
Mountain Cem
Blacktail Creek
Sand Creek
Creek
Railroad
Abandoned
Radio Tower
Prospects
Adit
Trailer Park
Sub Station
Mine Shaft
Aqueduct
4WD
R8W R7W
25
26
27
30
31
34
35
36

PROJECTION: STATE PLANE
ZONE: MONTANA
DATUM: NAD 83
UNITS: FEET
SOURCE: USGS QUAD

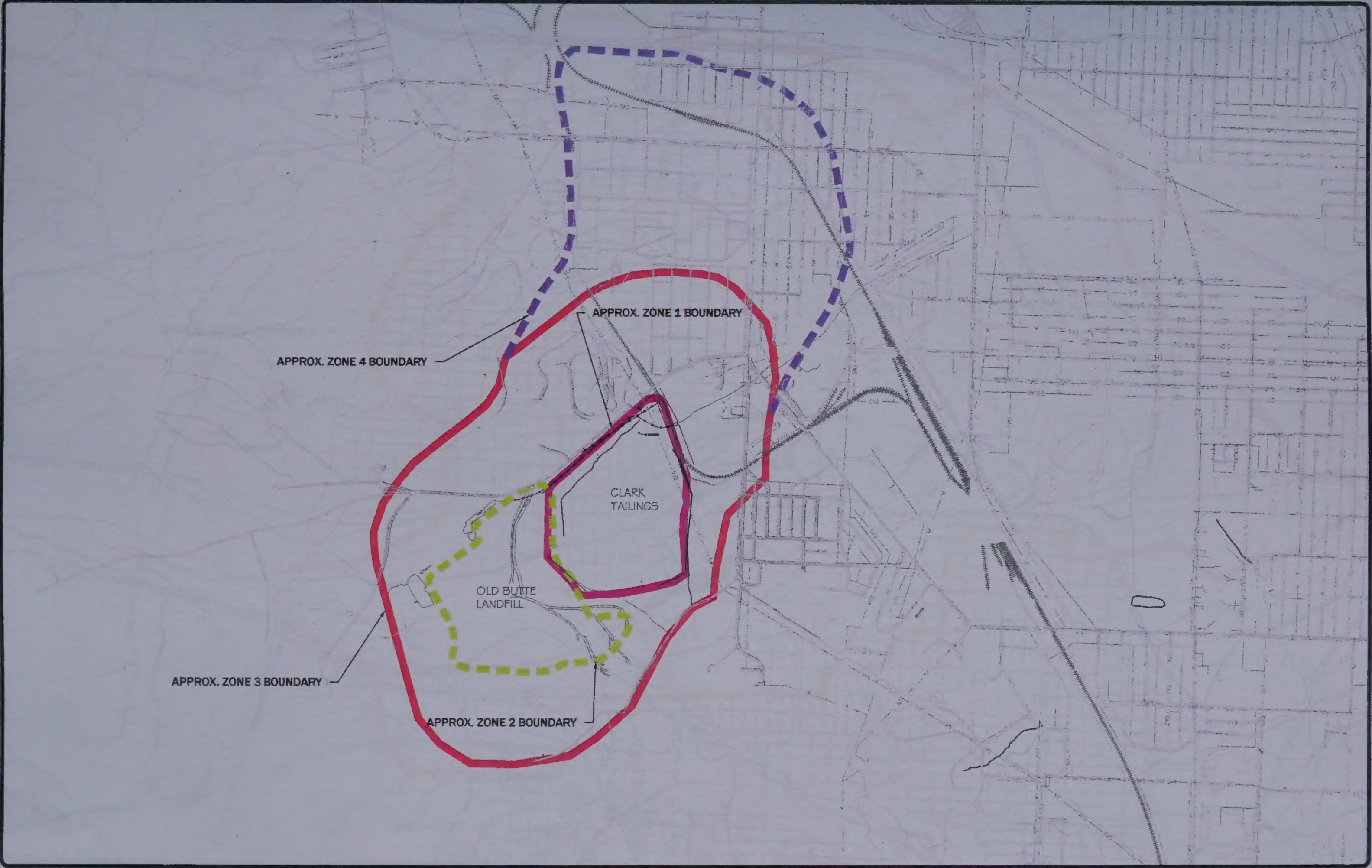
SCALE IN FEET
0 1000 2000

FIGURE 1 GENERAL LOCATION MAP OLD BUTTE LANDFILL SITE

PIONEER TECHNICAL SERVICES, INC.

Butte, Helena, Anaconda

DATE: 4/13/09


APPROX. ZONE 1 BOUNDARY
APPROX. ZONE 4 BOUNDARY
CLARK TAILINGS
OLD BUTTE LANDFILL
APPROX. ZONE 3 BOUNDARY
APPROX. ZONE 2 BOUNDARY

NOTES:
ZONES 1 & 2 - NO NEW WELLS SHALL BE DRILLED

ZONE 3 - NO NEW WELLS PUMPING MORE THAN 10 gal/min SHALL BE DRILLED

ZONE 4 - NO NEW WELLS PUMPING MORE THAN 200 gal/min SHALL BE DRILLED

N

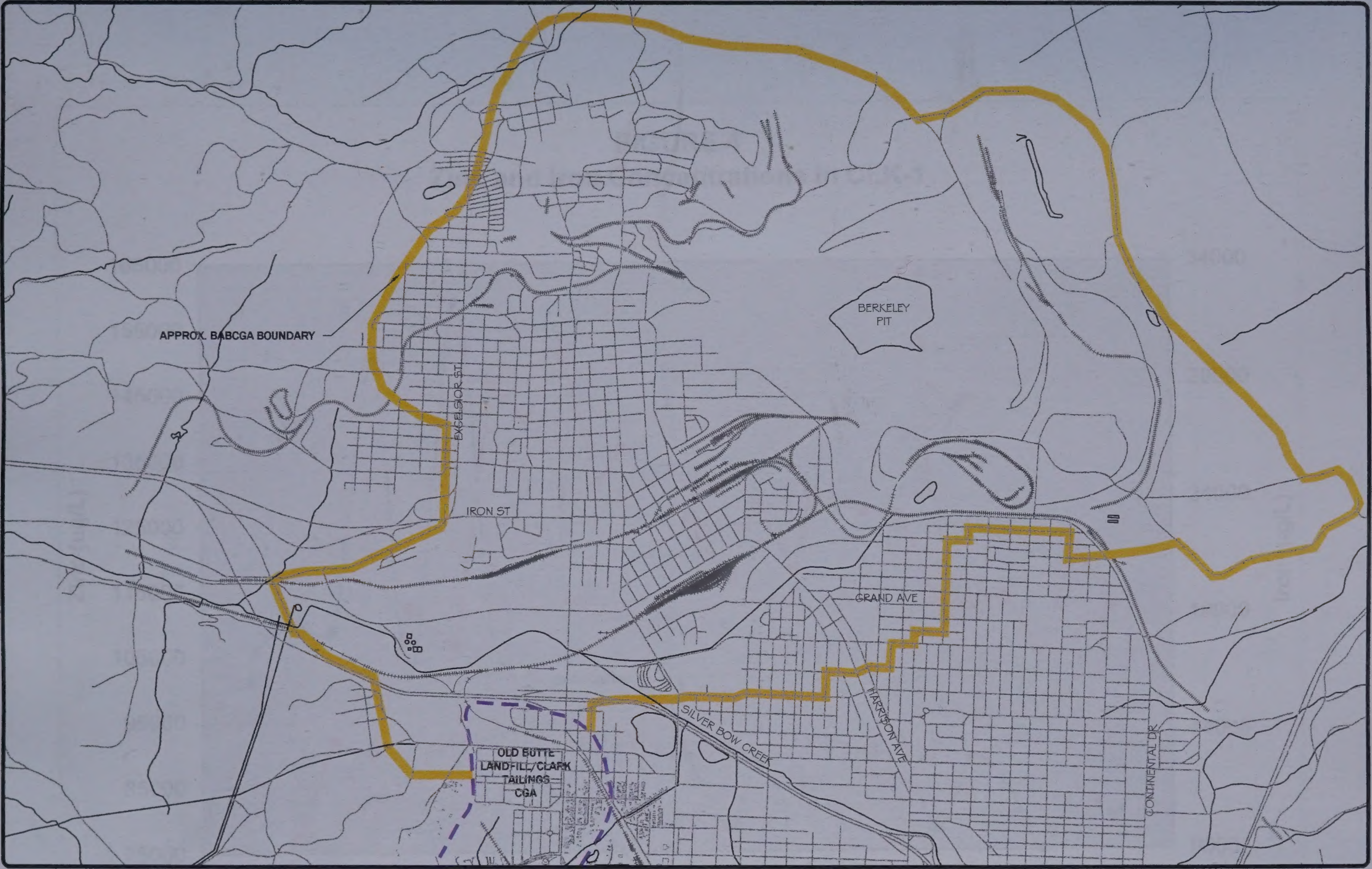
PROJECTION: STATE PLANE
ZONE: MONTANA
DATUM: NAD 83
UNITS: FEET
SOURCE:

SCALE IN FEET
0 750 1500

FIGURE 2 LOCATION OF CONTROLLED GROUNDWATER AREA OLD BUTTE LANDFILL SITE

PIONEER TECHNICAL SERVICES, INC.
Butte, Helena, Anaconda

DATE: 4/13/09


APPROX. BABCGA BOUNDARY
BERKELEY PIT
EXCELSIOR ST
IRON ST
GRAND AVE
SILVER BOW CREEK
HARRISON AVE
CONTINENTAL DR
OLD BUTTE LANDFILL/CLARK TAILINGS CGA

N

PROJECTION: STATE PLANE
ZONE: MONTANA
DATUM: NAD 83
UNITS: FEET
SOURCE:

SCALE IN FEET
0 1500 3000

FIGURE 3

LOCATION OF PROPOSED CONTROLLED GROUND WATER AREA BUTTE MINE FLOODING OPERABLE UNIT AND BUTTE PRIORITY SOILS

PIONEER TECHNICAL SERVICES, INC.
Butte, Helena, Anaconda

DATE: 4/13/09

FIGURE 4
Zinc and Iron Concentrations in CLK-1

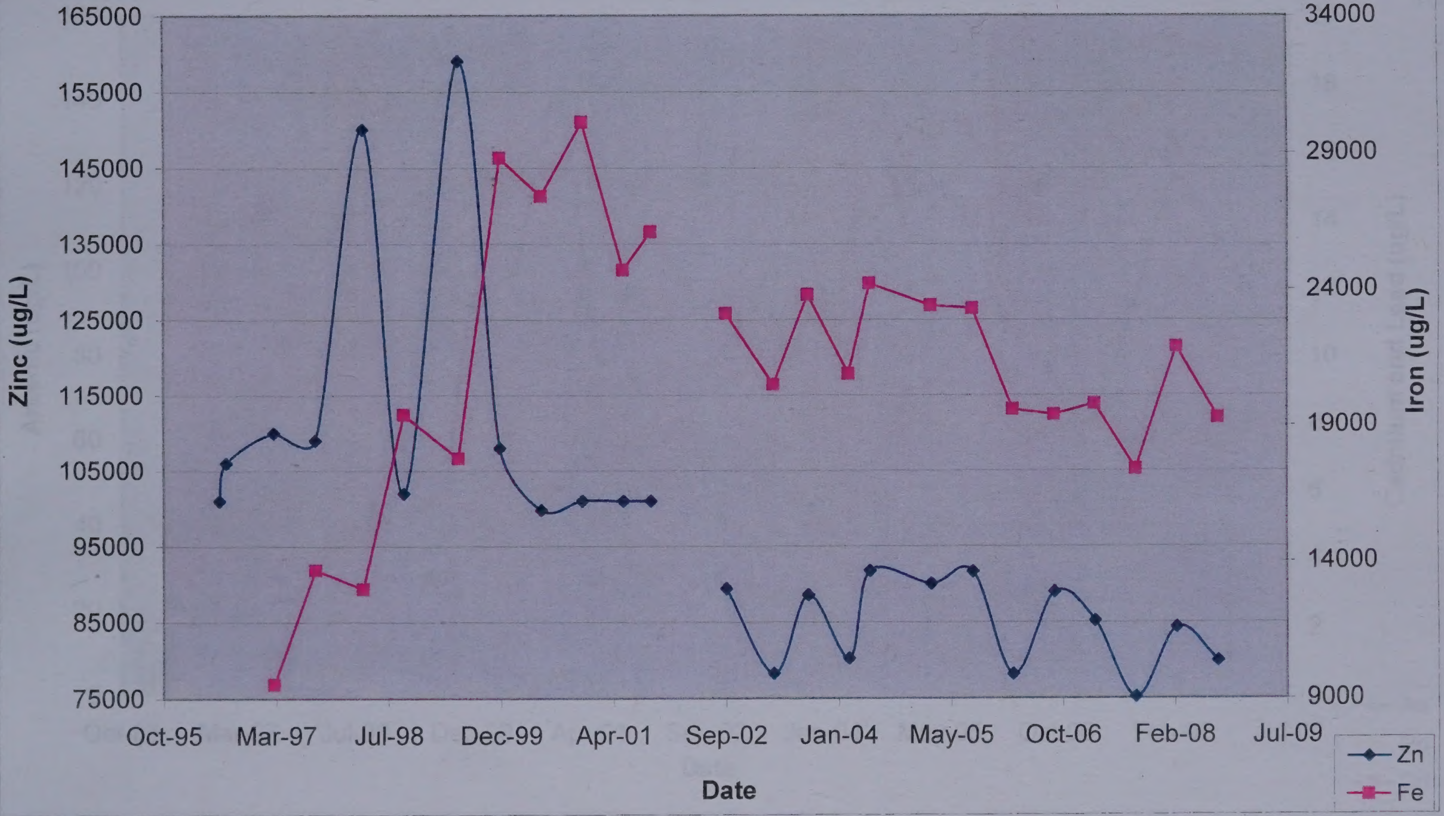


FIGURE 5

Cadmium, Arsenic and Lead Concentrations in CLK-1

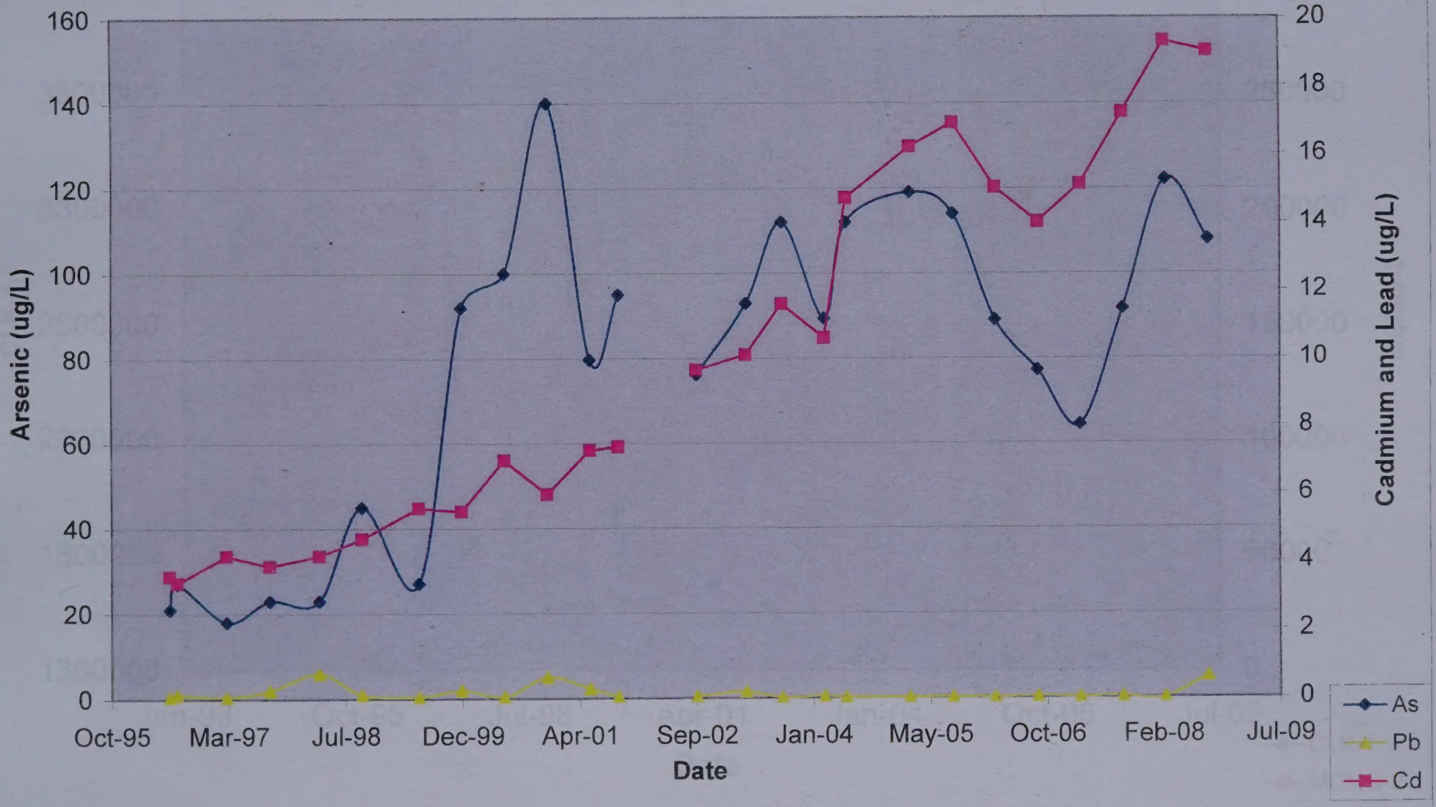


FIGURE 6
Sulfate Concentrations (ug/L) in CLK-1 and MBMG-2

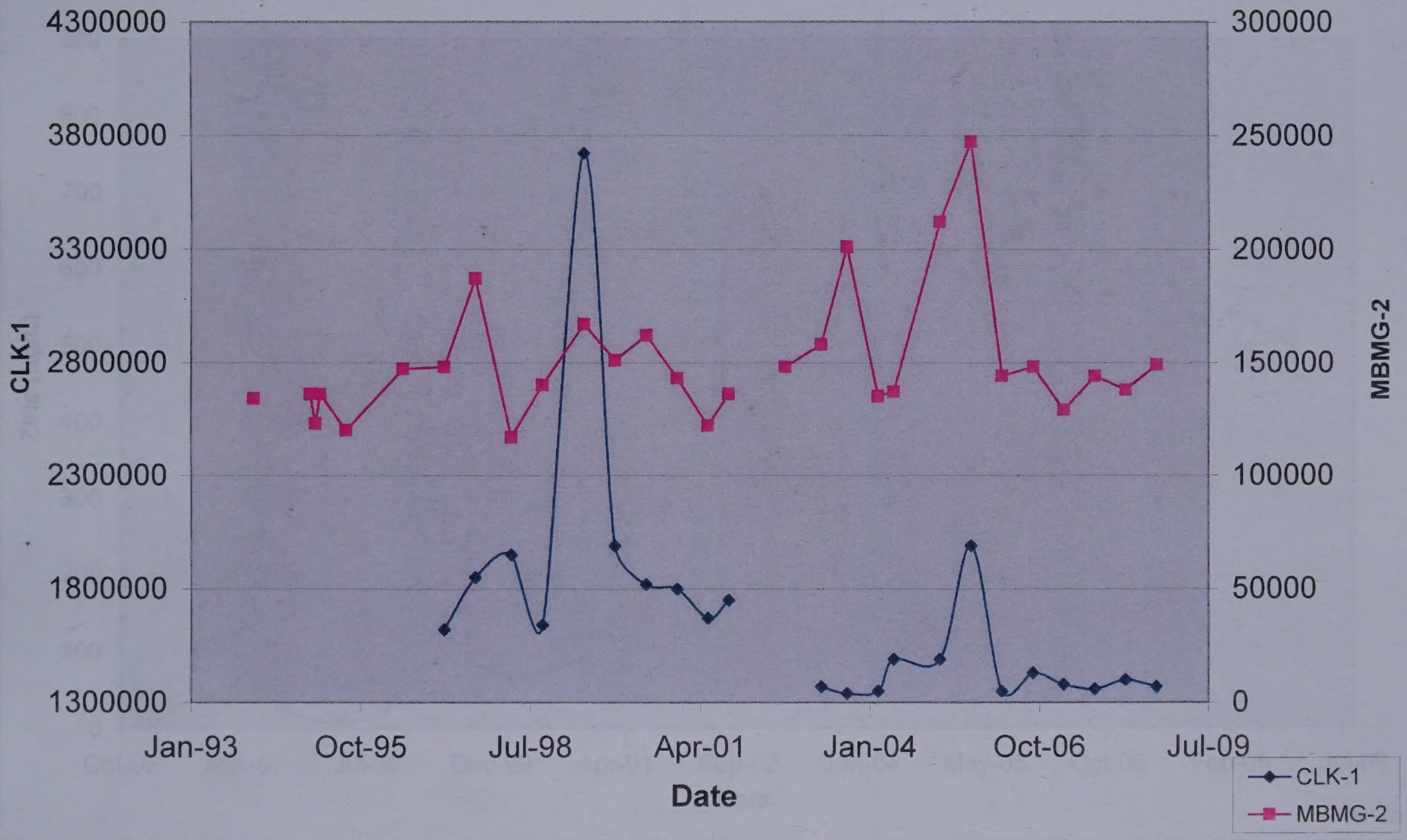


Figure 7
Zinc Concentrations in CLK-2

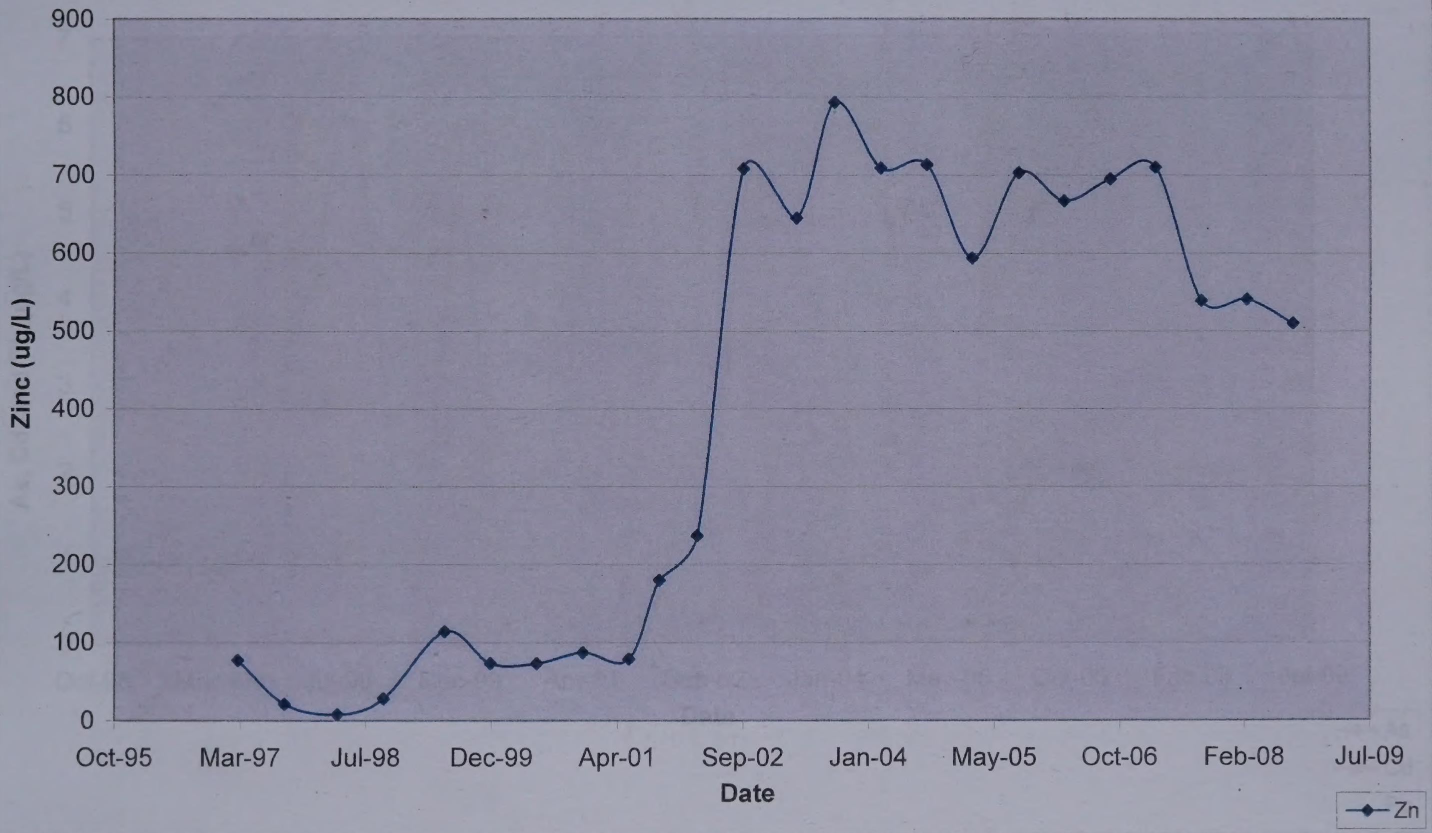


FIGURE 8
Arsenic, Cadmium and Lead Concentrations in CLK-2

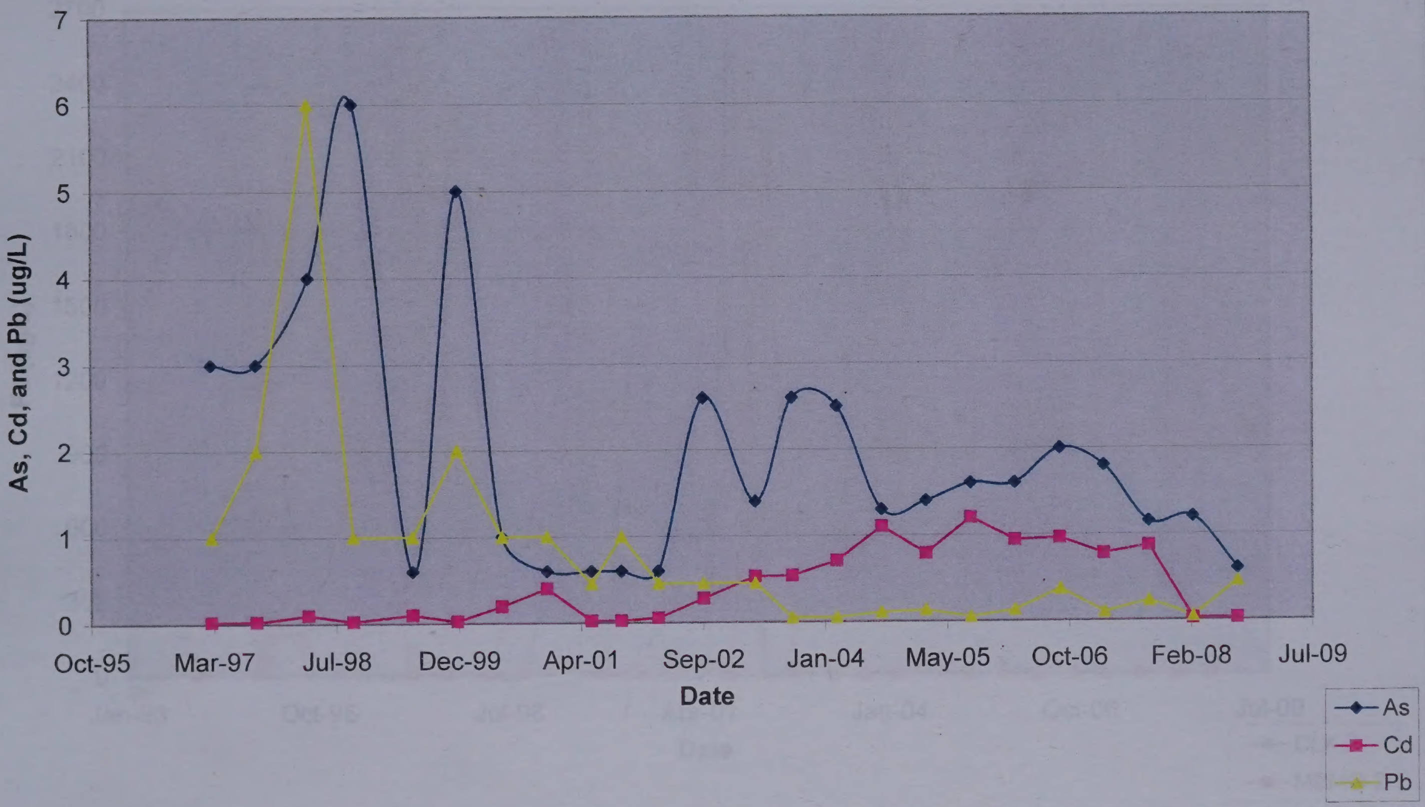


FIGURE 9
Iron Concentrations (ug/L) in CLK-2 and MBMG-2

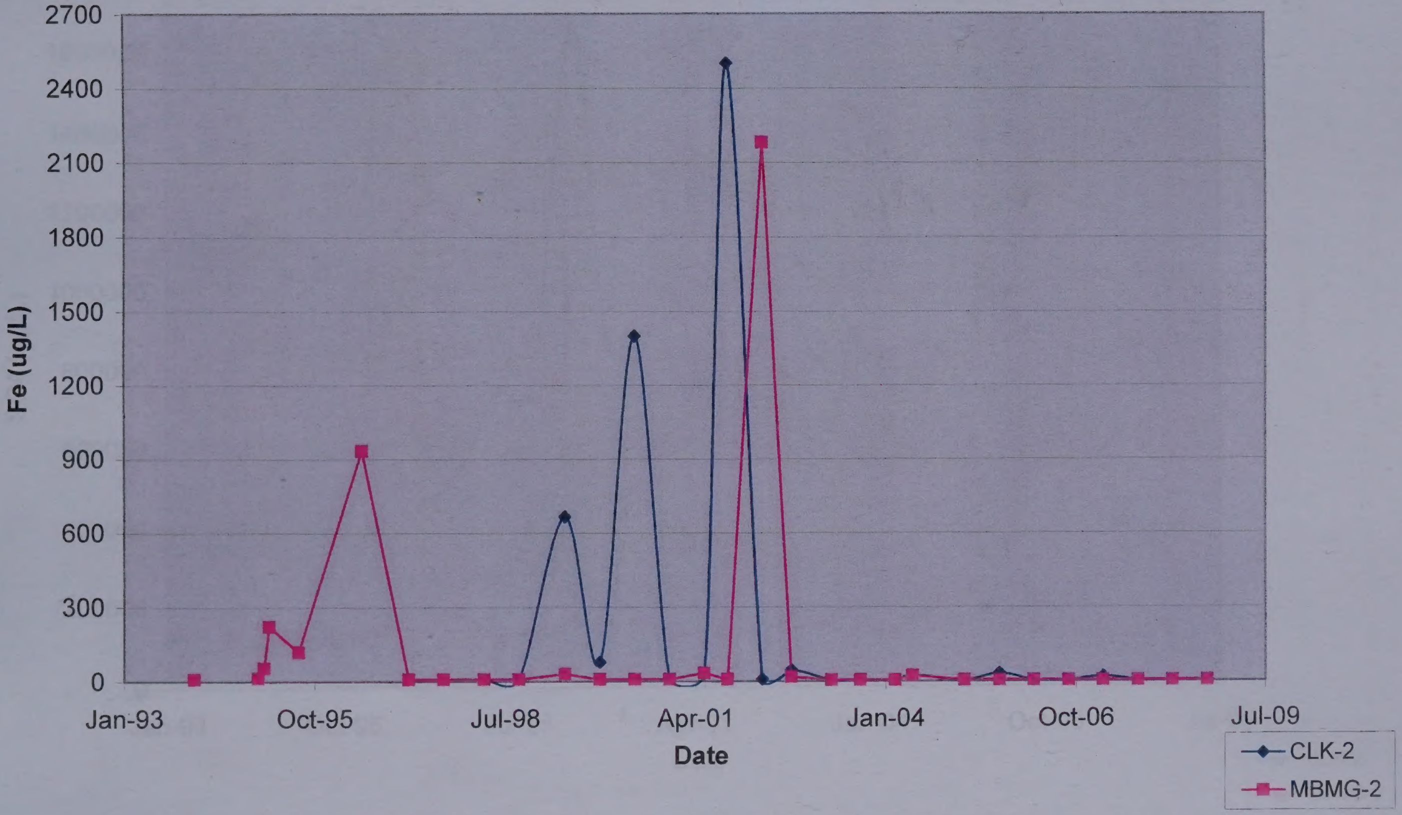


FIGURE 10
Sulfate Concentrations (ug/L) in CLK-2 and MBMG-2

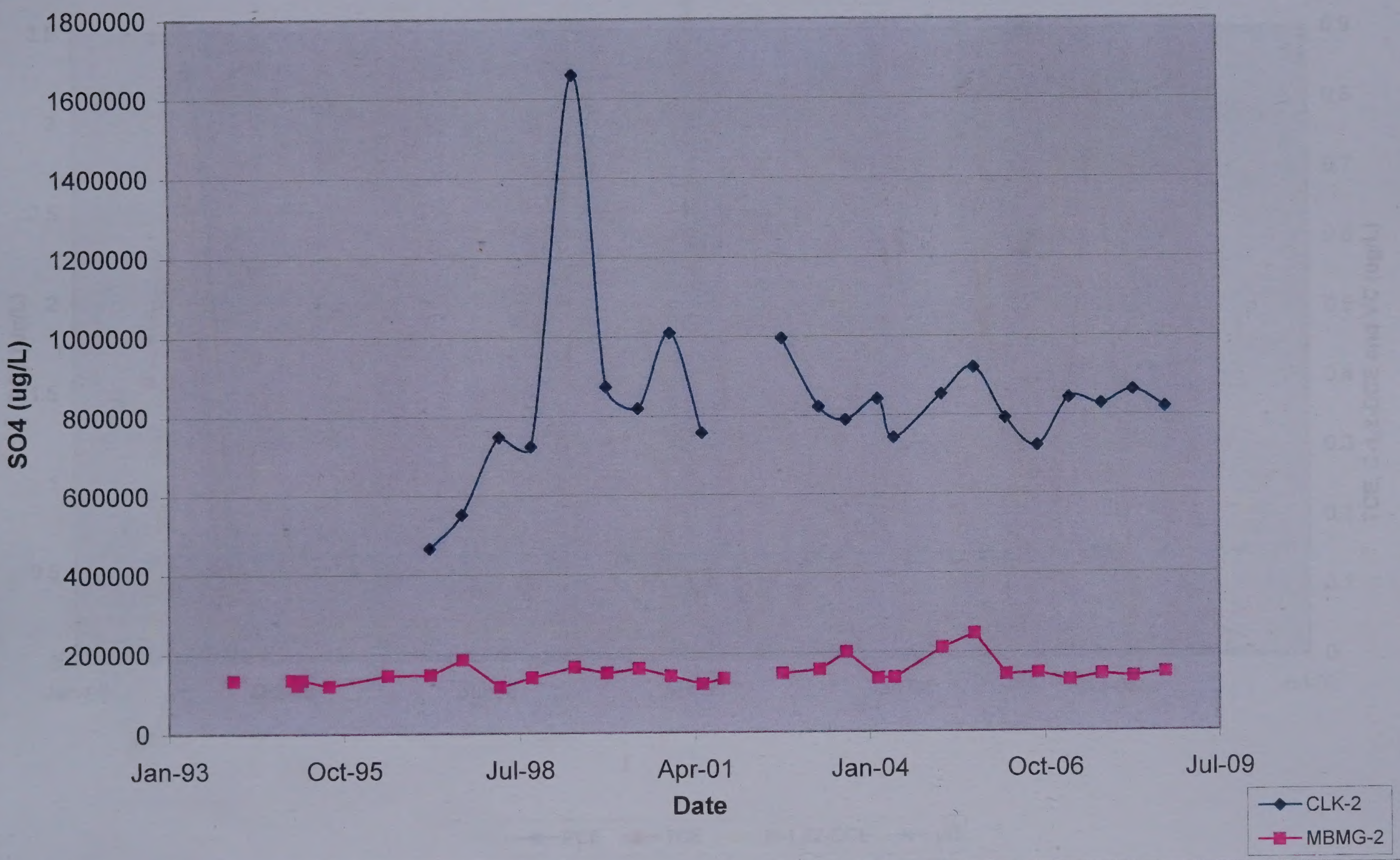


FIGURE 11
PCE, TCE, C-1,2-DCE and Vinyl Chloride Concentrations in BSB-A1

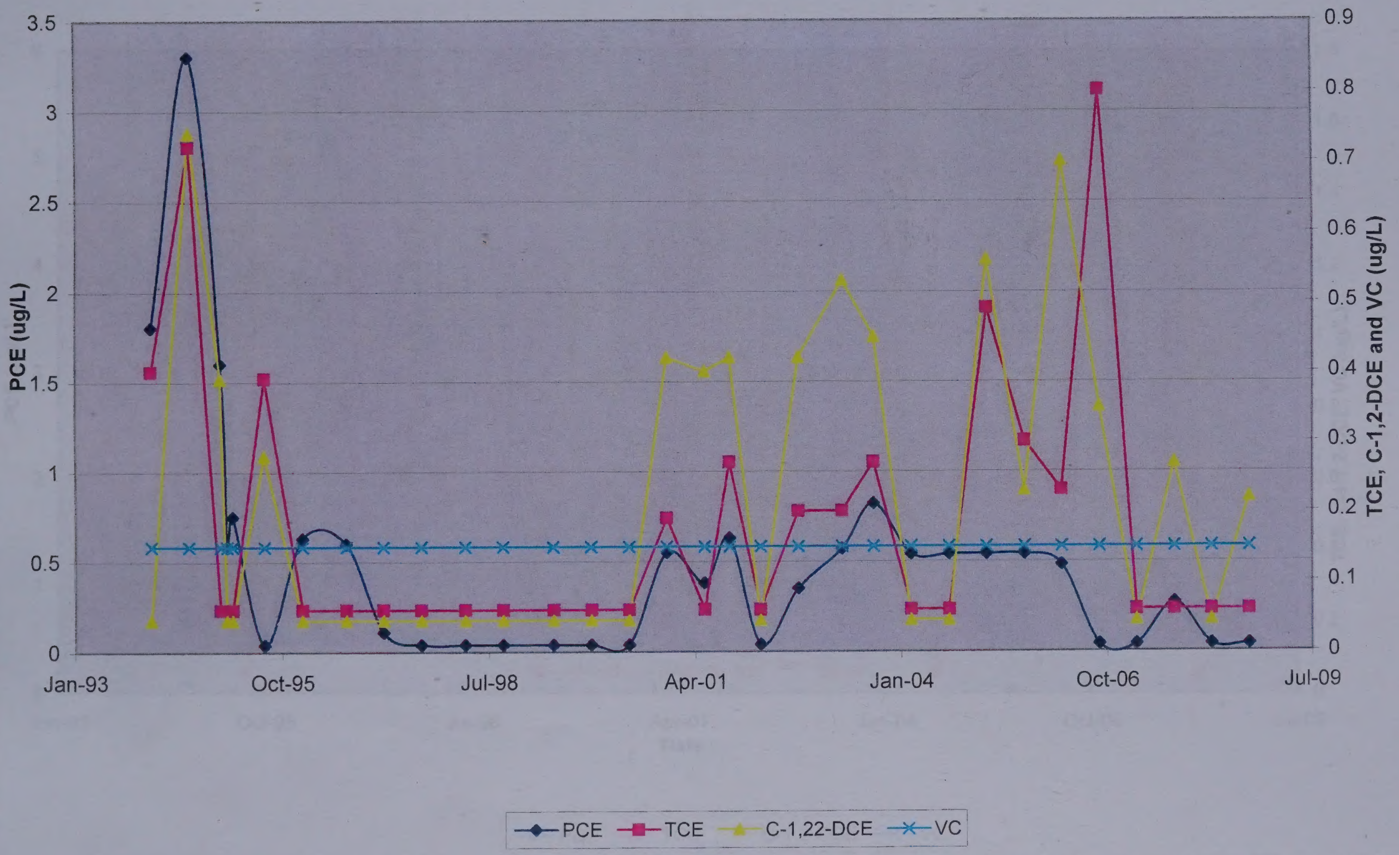


FIGURE 12
PCE, TCE, cis-1,2-DCE and Vinyl Chloride Concentrations in BSB-A5

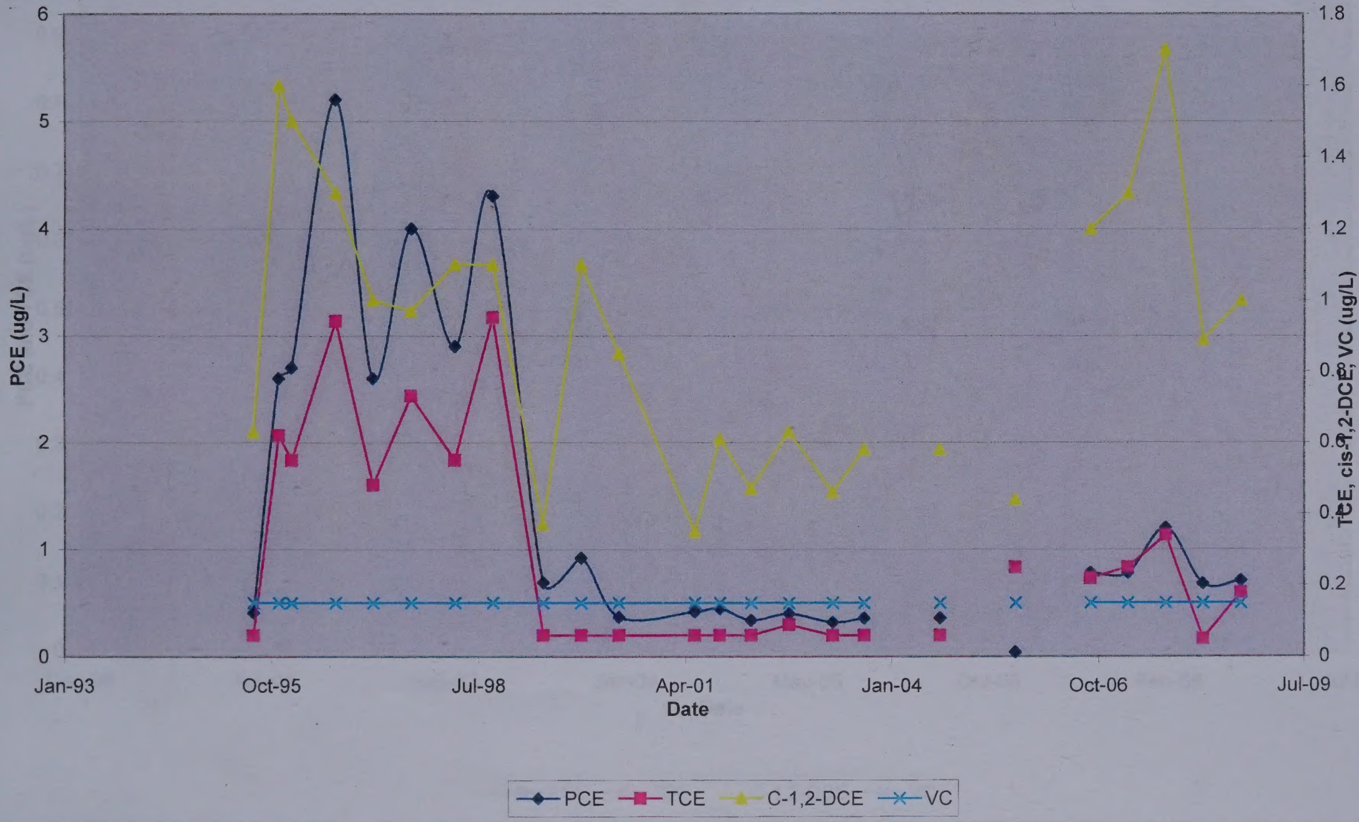
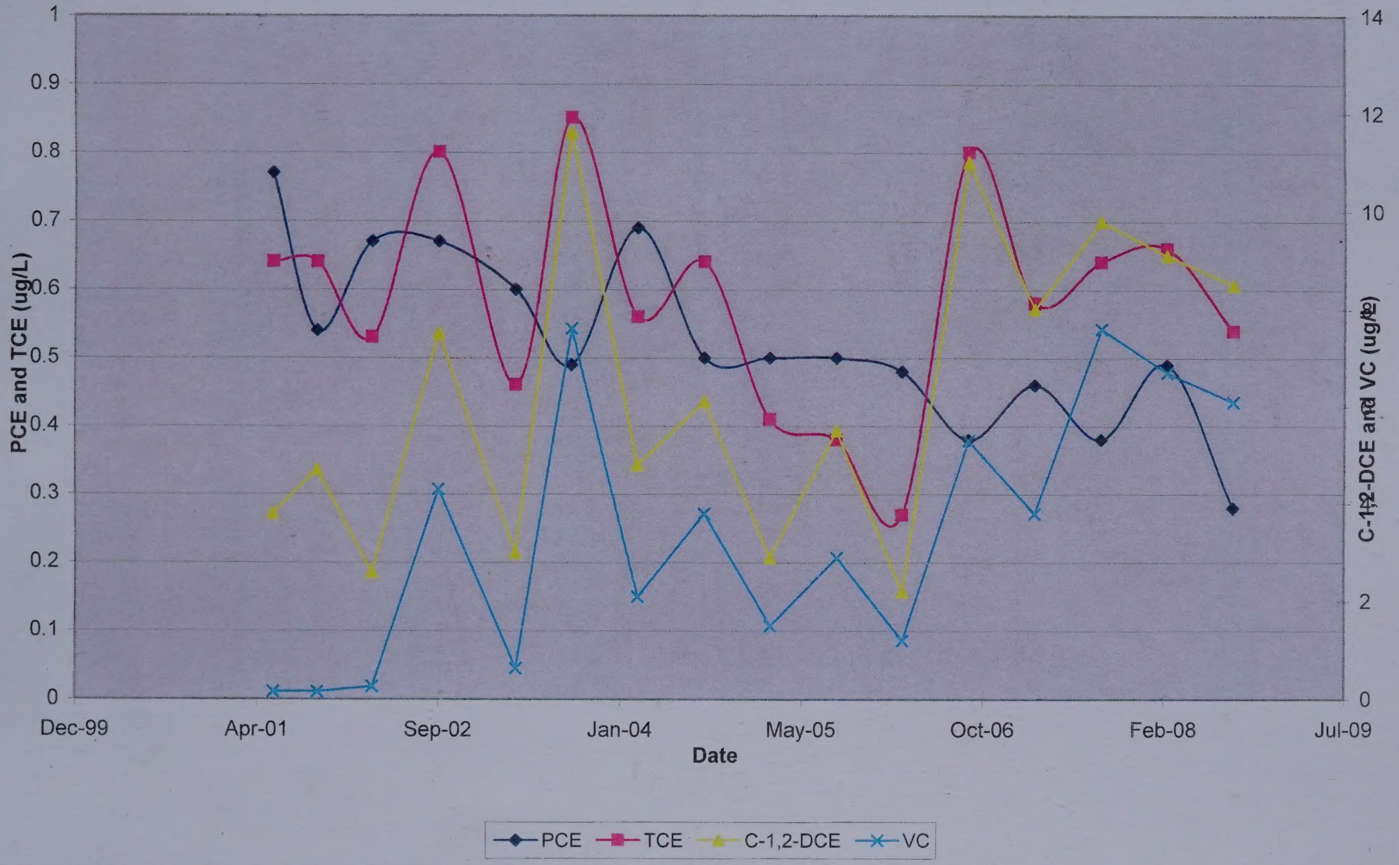


FIGURE 13
PCE, TCE, cis-1,2-DCE, and Vinyl Chloride Concentrations in BSB-A6R



APPENDIX A

DEQ IRRIGATION GUIDANCE LETTER OF MARCH 13, 1998

DEPARTMENT OF ENVIRONMENTAL QUALITY
PERMITTING & COMPLIANCE DIVISION
Community Services Bureau
Waste Management Section

MARC RACICOT, GOVERNOR

STATE OF MONTANA

Phone: (406)444-4400
Fax: (406)444-1374

Metcalf Building
1520 E Sixth Ave
PO Box 200901
Helena, MT 59620-0901

March 13, 1998

received
3/18/98

Jimmy Johnson
Director of Public Works
Butte-Silver Bow County
Courthouse
Butte, MT 59701

Dear Jimmy:

As we discussed on the phone, closed landfills can be irrigated to support their final end use. How else would we have soccer fields here in Helena? In order to prevent infiltration into the underlying waste, the water should be applied at agronomic uptake rates for the type of grass involved, minus the incident precipitation (i.e., turn the sprinklers off when it is raining and only use enough to keep the grass growing). The local National Resource Conservation Service office or County Extension Agent should be able to help you in determining what the rate of water application should be.

If you have any further questions on this matter, please feel free to contact me. My direct phone line is 406-444-5294.

Sincerely,

F. Patrick Crowley
Acting Section Supervisor

File: Old Butte landfill\closure
Path: CB5403\wp\landfill\closure\BSB\watering

cc'd to Stilwell, Hendricks
3/18/98

"AN EQUAL OPPORTUNITY EMPLOYER"

APPENDIX B

ESTIMATE OF HYDRAULIC CONDUCTIVITY UTILIZING LOW-FLOW SAMPLING

Table X1: Estimate of Hydraulic Conductivity Utilizing Low-Flow Sampling

Location	Steady-State Discharge, Q liters per minute ▾		Static Depth to Water (ft)	Steady-State Depth to Water (ft)	Steady-State Drawdown, H (ft)	Total Well Depth (ft)	Length of Screen (ft)	Intake Length, L (ft)	Radius of Screen, R (ft)		K (ft/day) centimeters per second ▾	
	(l/min)	(ft^3/day)							(in.)	(ft.)	(ft/day)	(cm/sec)
MBMG-2	0.25	12.7	10.91	11.06	0.15	23.25	10	10	2	0.166667	6.5	2.3E-03
BSB-A1	0.2	10.2	38.09	38.81	0.72	57	20	18.19	2	0.166667	0.7	2.4E-04
BSB-A6R	0.15	7.6	52.11	52.55	0.44	59.75	20	7.2	2	0.166667	1.7	6.0E-04
CLK-2	0.946	48.1	41.35	42.79	1.44	46.9	20	4.11	2	0.166667	5.0	1.8E-03
CLK-1	0.946	48.1	7.27	7.44	0.17	19	10	10	2	0.166667	22.0	7.8E-03
AVERAGE											7.2	0.0025

Instructions:

Enter data in all selectable cells. Locked cells contain formulas.

To modify worksheet, select Tools- Protection- Unprotect Sheet

Objective(s):

Estimate hydraulic conductivity utilizing pumping rates from low-flow sampling.

Criteria:

No other suitable hydraulic conductivity estimates are available.

Assumptions/Methods:

Utilize Dachler (1936) half-ellipsoid method.

$$Q = \frac{2\pi LKH}{2.303\ \log\left[\frac{L}{R} + \sqrt{1 + \left(\frac{L}{R}\right)^2}\right]}$$

Dachler (1936) Equation modified to solve for K:

$$K = \frac{Q * \left(2.303\ \log\left[\frac{L}{R} + \sqrt{1 + \left(\frac{L}{R}\right)^2}\right]\right)}{2\pi LH}$$

Table 1 Ranges of horizontal hydraulic conductivity of geologic material

[All values are feet per day]

Aquifer Material	**Extreme Minimum**	**Likely Minimum**	**Likely Maximum**	**Extreme Maximum**
Unconsolidated Sedimentary Rock				
Gravel [1,5]	90	300	3000	3000
Sand and Gravel Mixes [1]	1	30	300	300
Coarse Sand [1]	50	70	300	300
Medium Sand [1,5]	1	20	70	200
Fine Sand [1,5]	0.05	3	20	20
Gulf Coast Aquifer Systems (6603 values) [2]	2	30	200	800
Stream Terrace Deposit, Fort Worth, Texas (59 values) [3]	0.01	1	100	300
Surficial Aquifer, central Florida (fine sand and silt values) [4]	0.01	0.1	30	50
Silt, Loess [5]	0.0003	0.001	0.1	6
Till [1,5]	0.0000003	0.003	0.3	0.6
Clay soils (surface) [1]	0.01	0.01	1	1
Clay [5,7]	1.00E-06	1.00E-05	1.00E-04	1.00E-03

Method limits are from 10^{-6} cm sec to 10^{-3} or 10^{-2} cm sec

Reference table for hydraulic conductivities from USGS Open File Report 02-197 is provided at right (USGS, 2002)

Conclusions

Hydraulic conductivity from BSB-A6R, with a light gray sandy silty matrix and a calculated hydraulic conductivity of 1.7 feet per day, appears to be appropriate in comparison with the USGS reference table (USGS, 2002) for fine sand and silt values (0.1 to 30

Legend

0.7 Hydraulic conductivity value within confidence range of 0.0028 feet per day and 2.8 feet per day (10-2 cm per second [cm/sec] to 10-6 cm/sec)

22 Hydraulic conductivity value nearing upper confidence range of 28 feet per day (10-2 cm/sec)

30 Hydraulic conductivity value above upper confidence range of 0.0028 feet per day (10-2 cm/sec) or below lower range of 28 feet per day (10-6 cm/sec)

References

Dachler, 1936

Robbins, G.A., Aragon-Jose, A.T., Romero, A. Determining Hydraulic Conductivity Using Pumping Data from Low-Flow Sampling. Ground Water Volume47, No. 2. March-April 2009.

Checked by MWD on 4-24-2009

W. R

APPENDIX C

OLD SILVER BOW LANDFILL
SEPTEMBER 2008 GROUNDWATER MONITORING SUMMARY

OLD SILVER BOW LANDFILL
SEPTEMBER 2008 GROUNDWATER MONITORING

The September 2008 round of sampling at the Old Silver Bow Landfill included sampling for the full Table 2 list of analytics in accordance with the Assessment Monitoring program. Table 1, attached, summarizes the analytical results. The discussion below compares these data to previous results and to current Maximum Contaminant Levels (MCLs) and Montana Human Health Standards (HHSs).

Well MBMG-2 (up gradient):

No semi-volatiles, chlorinated acids, or pesticides were detected in the well during this sampling event. One volatile organic compound was detected in this well during this sampling event, Chloroform (ELI 0.42 J μg/L). Metals detected below the mean are; Ba (0.100 mg/L). There were no metals detected above the mean. Nitrate/nitrite (4.215 mg/L), Chloride (56 mg/l), and Sulfate (149 mg/L) were detected at concentrations below the mean.
No MCL or HHS exceedences were observed in this well during this sampling event.

Well BSB-A1 (North):

No semi-volatile, chlorinated acids, or pesticides were detected in the well during this sampling event. One volatile compound was detected; cis-1,2-Dichloroethene (ELI 0.22 Jμg/L) mean value of 0.22 μg/L. In accordance with the modified assessment-monitoring program, a sample for metals analyses was not collected from this well.
There were no inorganic compounds detected at levels above the mean during this sampling event in this well. Chloride (16.0 mg/L), sulfate (74 mg/L), and nitrate/nitrite (0.40 mg/L) were detected at levels below the mean.
No MCL or HHS exceedences were observed in this well during this sampling event.

Well BSB-A5 (Northeast Well):

In accordance with the modified assessment-monitoring program, a sample for metals analyses was not collected from this well. No semi-volatiles, chlorinated acids, or pesticides were detected in the well during this sampling event. Three volatile organic compounds were detected in this well during this sampling event, Tetrachloroethene (ELI 0.71 J μg/L), Trichloroethene (ELI 0.18 Jμg/L), and cis-1,2-Dichloroethene (ELI 1.0 μg/L).
Sulfate (544 mg/L), and COD (12 mg/L) were detected at levels below the mean.
Chloride (27 mg/L), and nitrate/nitrite (2.92 mg/L) were detected at levels above the mean. Sulfate exceeds the secondary USEPA MCL of 250 mg/L.

Well BSB-A6-R (Central Well):

Well BSB-A6-R is the replacement well for BSB-A6, removed during the construction of Timber Butte Youth Park. Thirteen volatile organic compounds (VOC's) were detected in this well; eight of the thirteen were detected at levels below the quantification limit. The thirteen volatile organic compounds were as follows:

- Benzene (0.58 J ug/L);
- Chloroethane (0.45 J ug/L);
- 1,4 – Dichlorobenzene (2.6 ug/L);
- Dichlorodifluoromethane (1.1 ug/L);
- 1,1-DCE (1.3 ug/L);
- Cis-1,2-DCE (8.5 ug/L);
- Trans-1,2-DCE (0.22 J ug/L);
- 1,2-Dichloropropane (0.44 J ug/L);

- Iodomethane (0.22 J ug/L);
- Methylene Chloride (0.20 J ug/L);
- Tetrachloroethene (0.28 J ug/L);
- Trichloroethene (0.54 J ug/L);
- Vinyl Chloride (6.1 ug/L).

No other semi-volatiles, chlorinated acids, or pesticides were detected. In accordance with the modified assessment-monitoring program, a sample for metals analyses was not collected from this well.

Chloride (57 mg/L, mean 53 mg/L), COD (199mg/L, mean 295 mg/L) and Sulfate (1180 mg/L, mean 1984 mg/L) were detected below their mean values. Sulfate exceeds the secondary USEPA MCL of 250 mg/L.

Well CLK-1 (Clark Tailings East Well):

In accordance with the modified assessment-monitoring program, no samples for organic analyses were collected from this well. The measured concentrations of the majority of metals were relatively low; the detected concentrations of arsenic (0.108 mg/L), cadmium (0.0190 mg/L), Zn (80.00 mg/L) and iron (19.3 mg/L), exceed US EPA MCL or Montana HHS standards.

Sulfate was detected at a concentration of 1370 mg/L, which exceeds the secondary MCL of 250 mg/L for this compound. Chloride was also detected (28 mg/L), with a mean value of 34 mg/L.

Well CLK-2 (Clark Tailings North Well):

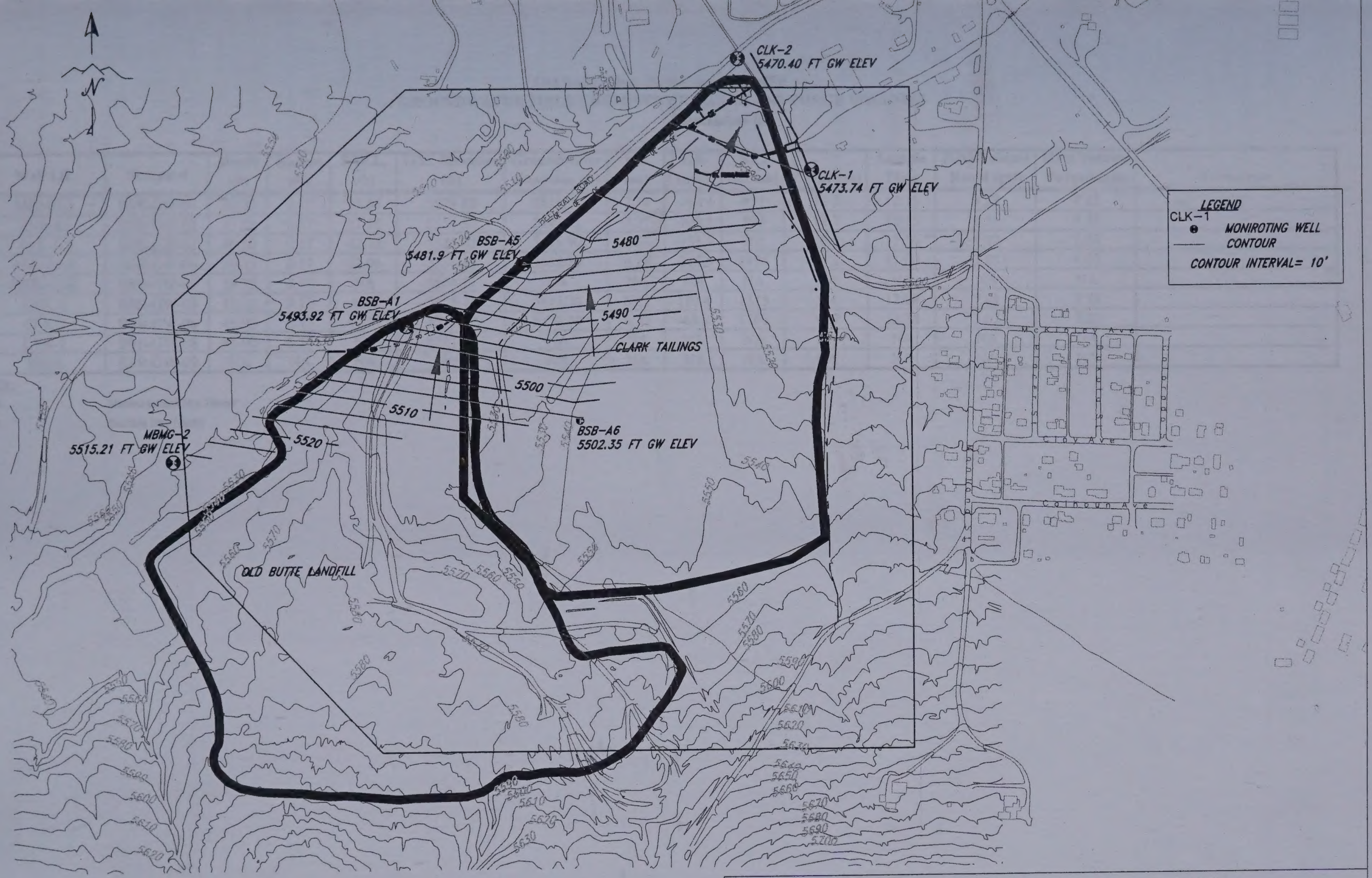
In accordance with the modified assessment-monitoring program, no samples for organic analyses were collected from this well. The measured concentrations of the majority of metals were relatively low; the detected concentrations of zinc (0.51 mg/L) and Copper (0.01mg/L) were low respective to MCLs, secondary MCLs, or Montana HHS concentrations for these metals.

Sulfate was detected at a concentration of 820 mg/L, which exceeds the secondary MCL for this compound. Chloride (56 mg/L) was detected below the mean of (57 mg/L).

Conclusion:

The September 2008 sampling event at the Old Butte-Silver Bow Landfill included sampling according to the modified assessment-monitoring program (see Table 2 for analytical data). The results for metals, inorganics, and organic contaminants obtained from this sampling event were comparable to previous results.

No field QA/QC was collected during this sampling event. All laboratory QA/QC was acceptable. A trip blank was analyzed for the organic analysis at the lab.


N
CLK-2
5470.40 FT GW ELEV
CLK-1
5473.74 FT GW ELEV
BSB-A5
5481.9 FT GW ELEV
BSB-A1
5493.92 FT GW ELEV
MBMG-2
5515.21 FT GW ELEV
BSB-A6
5502.35 FT GW ELEV
5480
5490
5500
5510
5520
CLARK TAILINGS
OLD BUTTE LANDFILL
McKinley Ave
Clay Ave
Calhoun Ave
LEGEND
CLK-1
MONIROTING WELL
CONTOUR
CONTOUR INTERVAL= 10'

PIONEER
TECHNICAL SERVICES, INC.

FIGURE 2
OLD BSB MUNICIPAL LANDFILL
SITE/CLARK TAILINGS FACILITY
SEPTEMBER 2008

SCALE: 1"=600''
DATE: 12/2/08

STA1\D\DATA\OLD BUTTE LANDFILL\SAMPLING-2008\SEPTEMBER 2008 GW.DWG

Old Butte-Silver Bow County Landfill
GROUNDWATER FIELD CHEMISTRY RESULTS AND PURGE VOLUMES
September-08

Well I.D.	Sample #	Depth (ft)	Radius (ft)	S.W.L. (ft)	TOC Elevation (ft)	Groundwater Elevation (ft)	pH. (su)	E.h. (mV)	S.C. (uS/cm)	T (Celsius)	Sample Time	H2O Volume Req'd (gal)	H2O Volume Purged (gal)	Comments
MBMG-2	BSB-GW-01	23.25	0.17	14.67	5529.88	5515.21	7.14	-183.4	477	11.5	12:15	4.29	4.25	
BSB-A1	BSB-GW-02	57.00	0.17	37.58	5531.50	5493.92	7.27	-102.3	307	12.7	10:15	9.71	9.75	
BSB-A5	BSB-GW-03	46.50	0.17	42.72	5524.62	5481.90	5.65	-151.7	763	10.5	11:30	1.89	2.00	
BSB-A6-R	BSB-GW-04	59.75	0.17	52.06	5554.41	5502.35	6.29	-215.4	1495	13.2	11:00	3.85	4.00	
BSB-A6-R	BSB-GW-07	59.75	0.17	NA	5554.41	NA	NA	NA	NA	NA	NA	NA	NA	
CLK-1	BSB-GW-05	19.00	0.17	4.99	5478.73	5473.74	6.07	189.4	1513	9.9	12:00	7.01	7.75	
CLK-2	BSB-GW-06	46.90	0.17	40.77	5511.17	5470.40	6.32	-68.8	1163	10.7	12:36	3.07	3.25	
CLK-2	BSB-GW-08	46.90	0.17	NA	5511.17	NA	NA	NA	NA	NA	NA	NA	NA	
Blank	BSB-GW-09	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	

KEY:

NA	Measurement Not Taken
SA	Sample Not Taken

SAMPLE NUMBER WELL ANALYTE (units):	BSB-GW-O1 MBMG-2	BSB-GV BSB-	ROTECTION STANDARDS EPA CL*	 MONTANA HHS	GW PROTECTION STANDARDS USEPA MCL*	 MONTANA HHS
DISSOLVED METALS (mg/L)						
Antimony	< 0.005	N	0.006	0.014	0.006	0.014
Arsenic	< 0.005	N	0.05	0.018	0.05	0.018
Barium	0.100	N	2	1	2	1
Beryllium	< 0.001	N	0.004	0.040	0.004	0.040
Cadmium	< 0.001	N	0.005	0.005	0.0050	0.0050
Chromium	< 0.01	N	0.1	0.1	0.1	0.1
Cobalt	not reported	N	---	---	---	---
Copper	< 0.01	N	1.3 (a)	1	1.3 (a)	1
Iron	< 0.03	N	0.3 (s)	0.3	0.3	0.3
Lead	< 0.01	N	0.015 (a)	0.015	0.015 (a)	0.015
Mercury	< 0.001	N	0.002	0.00014	0.002	0.00014
Nickel	< 0.01	N	0.1	0.1	0.1	0.1
Selenium	< 0.005	N	0.05	0.05	0.05	0.05
Silver	< 0.005	N	0.1 (s)	---	0.1	---
Thallium	< 0.005	N	0.002	0.0017	0.002	0.0017
Tin	not reported	N				
Vanadium	< 0.1	N	---	---	---	---
Zinc	< 0.01	N	5 (s)	5	5	5
INORGANICS (mg/L)						
Chloride	56	1	250 (s)	---	250	---
COD	8.0	< 1	---	---	---	---
Conductivity (umhos/cm)	786	4	---	---	---	---
Cyanide	< 0.005	< 0	---	---	---	---
Nitrate\Nitrite - N	4.21	0	10	---	10	---
pH	7.0	6				
Sulfate	149	7	250 (s)	---	250	---
Sulfide	NR	N				
EPA METHOD 8260 (ug/L)						
Acetone	< 20.0	< 2				
Benzene	< 1.0	< 1				
Carbon Disulfide	< 1.0	< 1	---	---	---	---
Chloroethane	< 1.0	< 1				
Chloroform	(ELI 0.42J)< 1.0	< 1	---	57	---	57
Chlormethane	< 1.0	< 1				
1,4-Dichlorobenzene	< 1.0	< 1				
Dichlorodiflouromethane	< 1.0	< 1				
1,1-Dichloroethane	< 1.0	< 1				
1,2-Dichloroethane	< 1.0	< 1				
cis-1,2-Dichloroethene	< 1.0	(ELI 0.22J)< 1	70	70	70	70
trans-1,2-Dichloroethene	< 1.0	< 1				
1,2-Dichloropropane	< 1.0	< 1				
4-Isopropyltoluene	< NR	N				
Iodomethane	< 1.0	< 1				
Methylene Chloride	< 1.0	< 1				
Naphthalene	< 1.0	< 1				
Tetrachloroethene	< 1.0	< 1	5	8	5	8
Trichloroethene	< 1.0	< 1				
1,2,4-Trimethylbenzene	NR	N				
Vinyl Chloride	< 1.0	< 1				
EPA METHOD 8270 (ug/L)						
bis(2-ethylhexyl)Phthalate	< 10	< 1				
EPA METHOD 8151 (ug/L)	ND	N				
EPA METHOD 8081 (ug/L)	NR	N				

* MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
NA = Not enough sample available for analysis
NR = Analysis Not Requested
ND = Analyte Not Detected
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
NS= Sample Not Collected (Frozen Well-CLK-1)
SA = Sample Not Taken

Bolded values are above the MCL, italicized bold values are above the State HHS.

TABLE I: ANALYTICAL DATA FOR GROUNDWATER SAMPLES, OLD SILVER BOW COUNTY LANDFILL
DATE SAMPLED: September, 25 2008

SAMPLE NUMBER WELL ANALYTE (units):	BSB-GW-O1 MBMG-2	BSB-GW-O2 BSB-A1	BSB-GW-O3 BSB-A5	BSB-GW-O4 BSB-A6-R	BSB-GW-O5 CLK-1	BSB-GW-O6 CLK-2	BSB-GW-07 BSB-A6R DUPE	BSB-GW-08 CLK-2 DUPE	BSB-GW-O9 Field Blank Trip Blank	GW PROTECTION STANDARDS		GW PROTECTION STANDARDS	
										USEPA MCL*	MONTANA HHS	USEPA MCL*	MONTANA HHS
DISSOLVED METALS (mg/L)													
Antimony	< 0.005	NR	NR	NR	< 0.005	< 0.005	NR	NR	NR	0.006	0.014	0.006	0.014
Arsenic	< 0.005	NR	NR	NR	0.108	< 0.005	NR	NR	NR	0.05	0.018	0.05	0.018
Barium	0.100	NR	NR	NR	< 0.100	< 0.100	NR	NR	NR	2	1	2	1
Beryllium	< 0.001	NR	NR	NR	< 0.001	< 0.001	NR	NR	NR	0.004	0.040	0.004	0.040
Cadmium	< 0.001	NR	NR	NR	0.019	< 0.001	NR	NR	NR	0.005	0.005	0.0050	0.0050
Chromium	< 0.01	NR	NR	NR	< 0.01	< 0.01	NR	NR	NR	0.1	0.1	0.1	0.1
Cobalt	not reported	NR	NR	NR	not reported	not reported	NR	not reported	not reported	- - -	- - -	- - -	- - -
Copper	< 0.01	NR	NR	NR	< 0.01	0.01	NR	NR	NR	1.3 (a)	1	1.3 (a)	1
Iron	< 0.03	NR	NR	NR	19.3	< 0.03	NR	NR	NR	0.3 (s)	0.3	0.3	0.3
Lead	< 0.01	NR	NR	NR	< 0.01	< 0.01	NR	NR	NR	0.015 (a)	0.015	0.015 (a)	0.015
Mercury	< 0.001	NR	NR	NR	< 0.001	< 0.001	NR	NR	NR	0.002	0.00014	0.002	0.00014
Nickel	< 0.01	NR	NR	NR	0.05	0.02	NR	NR	NR	0.1	0.1	0.1	0.1
Selenium	< 0.005	NR	NR	NR	< 0.005	< 0.005	NR	NR	NR	0.05	0.05	0.05	0.05
Silver	< 0.005	NR	NR	NR	< 0.005	< 0.005	NR	NR	NR	0.1 (s)	- - -	0.1	- - -
Thallium	< 0.005	NR	NR	NR	< 0.005	< 0.005	NR	NR	NR	0.002	0.0017	0.002	0.0017
Tin	not reported	NR	NR	NR	not reported	not reported	NR	NR	NR				
Vanadium	< 0.1	NR	NR	NR	< 0.1	< 0.1	NR	NR	NR	- - -	- - -	- - -	- - -
Zinc	< 0.01	NR	NR	NR	80	0.51	NR	NR	NR	5 (s)	5	5	5
INORGANICS (mg/L)													
Chloride	56	16	27	57	28	56	NR	NR	NR	250 (s)	- - -	250	- - -
COD	8.0	< 1.0	12.0	199	NR	NR	NR	NR	NR	- - -	- - -	- - -	- - -
Conductivity (umhos/cm)	786	472	1180	2340	2400	1860	NR	NR	NR	- - -	- - -	- - -	- - -
Cyanide	< 0.005	< 0.005	< 0.005	0.021	NR	NR	NR	NR	NR	- - -	- - -	- - -	- - -
Nitrate\Nitrite - N	4.21	0.40	2.92	< 0.05	NR	NR	NR	NR	NR	10	- - -	10	- - -
pH	7.0	6.9	5.6	6.0	6.1	6.3	NR	NR	NR				
Sulfate	149	74	544	1180	1370	820	NR	NR	NR	250 (s)	- - -	250	- - -
Sulfide	NR	NR	NR	NR	NR	NR	NR	NR	NR				
EPA METHOD 8260 (ug/L)													
Acetone	< 20.0	< 20.0	< 20.0	< 20.0	NR	NR	NR		NR				
Benzene	< 1.0	< 1.0	< 1.0	(ELI 0.58 J)< 1.0	NR	NR	NR		NR				
Carbon Disulfide	< 1.0	< 1.0	< 1.0	< 1.0	NR	NR	NR		NR	- - -	- - -	- - -	- - -
Chloroethane	< 1.0	< 1.0	< 1.0	(ELI 0.45 J)< 1.0	NR	NR	NR		NR				
Chloroform	(ELI 0.42J)< 1.0	< 1.0	< 1.0	< 1.0	NR	NR	NR		NR	- - -	57	- - -	57
Chlormethane	< 1.0	< 1.0	< 1.0	< 1.0	NR	NR	NR		NR				
1,4-Dichlorobenzene	< 1.0	< 1.0	< 1.0	2.6	NR	NR	NR		NR				
Dichlorodiflouromethane	< 1.0	< 1.0	< 1.0	1.1	NR	NR	NR		NR				
1,1-Dichloroethane	< 1.0	< 1.0	< 1.0	1.3	NR	NR	NR		NR				
1,2-Dichloroethane	< 1.0	< 1.0	< 1.0	< 1.0	NR	NR	NR		NR				
cis-1,2-Dichloroethene	< 1.0	(ELI 0.22J)< 1.0	1.0	8.5	NR	NR	NR		NR	70	70	70	70
trans-1,2-Dichloroethene	< 1.0	< 1.0	< 1.0	(ELI 0.22 J)< 1.0	NR	NR	NR		NR				
1,2-Dichloropropane	< 1.0	< 1.0	< 1.0	(ELI 0.44 J)< 1.0	NR	NR	NR		NR				
4-Isopropyltoluene	< NR	NR	NR	NR	NR	NR	NR		NR				
Iodomethane	< 1.0	< 1.0	< 1.0	(ELI 0.22 J)< 1.0	NR	NR	NR		NR				
Methylene Chloride	< 1.0	< 1.0	< 1.0	(ELI 0.20 J)< 1.0	NR	NR	NR		NR				
Naphthalene	< 1.0	< 1.0	< 1.0	< 1.0	NR	NR	NR		NR				
Tetrachloroethene	< 1.0	< 1.0	(ELI 0.71 J)< 1.0	(ELI 0.28J)< 1.0	NR	NR	NR		NR	5	8	5	8
Trichloroethene	< 1.0	< 1.0	(ELI 0.18 J)< 1.0	(ELI 0.54 J)< 1.0	NR	NR	NR		NR				
1,2,4-Trimethylbenzene	NR	NR	NR	NR	NR	NR	NR		NR				
Vinyl Chloride	< 1.0	< 1.0	< 1.0	6.1	NR	NR	NR		NR				
EPA METHOD 8270 (ug/L)													
bis(2-ethylhexyl)Phthalate	< 10	< 10	< 10	< 10	NR	NR	NR NR		NR				
EPA METHOD 8151 (ug/L)	ND	ND	ND	ND	NR	NR	NR NR		NR				
EPA METHOD 8081 (ug/L)	NR	NR	NR	NR	NR	NR	NR		NR				

* MCL definitions: a = action level, not an MCL; s = secondary MCL (aesthetics)
NA = Not enough sample available for analysis
NR = Analysis Not Requested
ND = Analyte Not Detected
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
NS= Sample Not Collected (Frozen Well-CLK-1)
SA = Sample Not Taken

Bolded values are above the MCL, italicized bold values are above the State HHS.

	STANDARDS					Median			
	USEPA	MT GW	MBMG-2		E	Exceeds	BLANK		LAB
Analyte	MCL*	HHS	Mean	Median	Mea	td. or Bkd.	Mean	Median	MDL
			n=29		n=8		n=18		
Ag	- -	100	0.1	0.1	(	None	0.8	0.1	0.21
As	50	20	2	2		LK1 (std)	1	1	0.11
Ba	2,000	2,000	139	137		None	1	0	1
Be	4	4	0.2	0.1	(	LK1(bkd)	0.1	0.1	0.07
Cd	5	5	0.1	0.1	(	std),CLK2(bkd)	0.03	0.03	0.05
Co	- -	- -	4	4		LK1 (bkd)	4	4	8.5
Cr	100	100	4	4		None	4	4	10
Cu	1,300(a)	1,300	2	2		None	2	2	1.3
Fe	- -	300	130	9		LK1(std)	10	9	10
Hg	2	2	0.06	0.05	0.	None	0.07	0.05	0.11
Ni	- -	100	7	7		LK2 (bkd)	7	7	13.3
Pb	15(a)	15	0.7	0.5	(	None	0.2	0.5	0.10
Sb	6	6	1	1		None	2	1	0.1
Se	50	50	1.1	0.4	(	None	0.6	0.4	0.53
Tl	2	2	1	1		None	0	1	0.04
V	- -	- -	8	8		None	2	3	2.1
Zn	- -	2,000	13	5		(std)CLK2(bkd)	7	5	5.3
			n=29		n=3		n=4		
Chloride	250,000(s)	- -	57,024	57,000	16,9	LK2 (bkd)	0.1	0.1	5000
Sulfate	250,000(s)	- -	150,207	144,000	96,8	6R,C1,2 (std)	2.5	2.5	5000
Nitrate	10,000	10,000	7,049	6,610	5	None	- -	- -	50
COD	- -	- -	38,266	16,000	30,6	,A6R (bkd)	- -	- -	5000
SC	- -	- -	764	763	4	6R,C1,2(bkd)	0	0	- -

* MCL definitions: a = action level, not a MCL; s = second

BDL values calculated as equal to one half the method de

TABLE 5-2 (updated 11/04/2008)
SILVER BOW COUNTY -OLD LANDFILL GROUNDWATER DATA SUMMARY
INORGANIC CONSTITUENTS (ug/L)

	STANDARDS														Mean	Median			
	USEPA	MT GW	MBMG-2		BSB-A1		BSB-A5		BSB-A6R		CLK-1		CLK-2		Exceeds	Exceeds	BLANK		LAB
Analyte	MCL*	HHS	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Std. or Bkd.	Std. or Bkd.	Mean	Median	MDL
			n=29		n=8		n=4		n=0		n=25		n=24				n=18		
Ag	- -	100	0.1	0.1	0.8	0.1	0.1	0.1	- -	- -	0.3	0.1	0.3	0.1	CLK1,CLK2(bkd)	None	0.8	0.1	0.21
As	50	20	2	2	2	2	3	2	- -	- -	78	89	2	2	CLK1 (std)	CLK1 (std)	1	1	0.11
Ba	2,000	2,000	139	137	88	79	26	27	- -	- -	32	31	28	27	None	None	1	0	1
Be	4	4	0.2	0.1	0.5	0.6	0.2	0.1	- -	- -	0.4	0.4	0.1	0.1	CLK1,A1(bkd)	CLK1(bkd)	0.1	0.1	0.07
Cd	5	5	0.1	0.1	0.2	0.2	0.0	0.0	- -	- -	10.1	9.7	0.4	0.2	CLK1(std),CLK2(bkd)	CLK1(std),CLK2(bkd)	0.03	0.03	0.05
Co	- -	- -	4	4	4	4	4	4	- -	- -	78	76	4	4	CLK1 (bkd)	CLK1 (bkd)	4	4	8.5
Cr	100	100	4	4	5	4	4	4	- -	- -	32	4	4	4	CLK1 (bkd)	None	4	4	10
Cu	1,300(a)	1,300	2	2	2	2	2	2	- -	- -	5	2	4	2	CLK1,CLK2 (bkd)	None	2	2	1.3
Fe	- -	300	130	9	25	22	36	36	- -	- -	21,179	20,900	204	9	CLK1(std)CLK2(bkd)	CLK1(std)	10	9	10
Hg	2	2	0.06	0.05	0.09	0.05	0.10	0.07	- -	- -	0.06	0.05	0.09	0.05	CLK2 (bkd)	None	0.07	0.05	0.11
Ni	- -	100	7	7	7	7	7	7	- -	- -	108	7	17	11	CLK1(std),CLK2(bkd)	CLK2 (bkd)	7	7	13.3
Pb	15(a)	15	0.7	0.5	0.8	0.5	0.8	0.5	- -	- -	1.2	0.5	0.8	0.5	CLK1 (bkd)	None	0.2	0.5	0.10
Sb	6	6	1	1	3	1	2	2	- -	- -	17	1	1	1	CLK1 (std)	None	2	1	0.1
Se	50	50	1.1	0.4	0.6	0.4	0.4	0.4	- -	- -	2.5	0.4	1.7	0.4	CLK1,CLK2(bkd)	None	0.6	0.4	0.53
Tl	2	2	1	1	4	5	3	1	- -	- -	0	0	1	0	None	None	0	1	0.04
V	- -	- -	8	8	3	3	3	3	- -	- -	5	3	3	3	None	None	2	3	2.1
Zn	- -	2,000	13	5	12	12	14	12	- -	- -	98,000	91,800	396	525	CLK1(std)CLK2(bkd)	CLK1(std)CLK2(bkd)	7	5	5.3
			n=29		n=32		n=20		n=16		n=22		n=23				n=4		
Chloride	250,000(s)	- -	57,024	57,000	16,997	17,000	25,605	25,000	53,350	54,500	34,245	34,000	57,343	61,600	CLK2 (bkd)	CLK2 (bkd)	0.1	0.1	5000
Sulfate	250,000(s)	- -	150,207	144,000	96,838	88,000	584,650	556,000	1,984,000	1,680,000	1,688,000	1,555,000	838,783	822,000	A5, A6R,C1,2 (std)	A5, A6R,C1,2 (std)	2.5	2.5	5000
Nitrate	10,000	10,000	7,049	6,610	578	535	2,646	2,690	44	25	- -	- -	- -	- -	None	None	- -	- -	50
COD	- -	- -	38,266	16,000	30,669	17,900	52,168	12,000	295,400	34,000	- -	- -	- -	- -	A5, A6R (bkd)	A1,A6R (bkd)	- -	- -	5000
SC	- -	- -	764	763	490	473	1,189	1,190	3,038	2,710	2,642	2,555	1,821	1,850	A5, A6R,C1,2(bkd)	A5, A6R,C1,2(bkd)	0	0	- -

* MCL definitions: a = action level, not a MCL; s = secondary MCL (asthetics)
BDL values calculated as equal to one half the method detection limit (MDL)

TABLE 5-3 (updated 11/10/2008)

SILVER BOW COUNTY -OLD LANDFILL GROUNDWATER DATA SUMMARY - ORGANIC CONSTITUENTS (ug/L)

Analyte	STANDARDS		MBMG-2		BSB-A1		BSB-A5		BSB-A6-R		Mean Exceeds Std. or Bkd	Median Exceeds Std. or Bkd.	BLANK		LAB MDL
	MCL	HHS	Mean	Median	Mean	Median	Mean	Median	Mean	Median			Mean	Median	
			n= 30		n= 32		n= 24		n= 16				n= 20		
Acetone	- -	- -	3.34	1.65	3.97	1.65	1.79	1.65	4.10	2.18	A1,A6R (bkd)	A6R (bkd)	4.51	1.65	3.3
Benzene	5	5	0.03	0.03	0.03	0.03	0.03	0.03	0.40	0.41	A6R (bkd)	A6R (bkd)	0.03	0.03	0.05
Carbon Disulfide	- -	- -	0.95	0.05	0.18	0.05	0.10	0.05	0.05	0.05	None	None	0.14	0.05	0.09
Chloroethane	- -	- -	0.05	0.05	0.05	0.05	0.05	0.05	0.20	0.05	A6R (bkd)	None	0.05	0.05	0.1
Chloroform	- -	60	0.48	0.45	0.05	0.05	0.05	0.05	0.06	0.05	None	None	0.10	0.05	0.09
Chloromethane	- -	- -	0.04	0.04	0.06	0.04	0.04	0.04	0.04	0.04	A1 (bkd)	None	0.13	0.04	0.08
1,2-Dichlorobenzene-8260	600	600	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	None	None	0.09	0.09	0.17
1,4-Dichlorobenzene-8260	75	75	0.06	0.06	0.06	0.06	0.06	0.06	0.59	0.06	A6R (bkd)	None	0.06	0.06	0.12
Dichlorodifluoromethane	- -	1400	0.04	0.04	0.05	0.04	0.08	0.04	3.34	3.50	A5,A6R (bkd)	A6R (bkd)	0.04	0.04	0.08
Dichlorofluoromethane	- -	- -	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	None	None	0.10	0.10	0.2
1,1-Dichloroethane	- -	- -	0.05	0.05	0.05	0.05	0.06	0.05	2.27	2.45	A6R (bkd)	A6R (bkd)	0.05	0.05	0.09
1,2-Dichloroethane	5	4	0.07	0.06	0.10	0.06	0.07	0.06	0.09	0.06	A1,A6R (bkd)	None	0.30	0.06	0.11
1,1-Dichloroethene	7	7	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	None	None	0.02	0.02	0.04
cis-1,2-Dichloroethene	70	70	0.05	0.05	0.22	0.05	0.91	0.93	6.32	5.80	A1,A5,A6R(bkd)	A5,A6R (bkd)	0.05	0.05	0.09
trans-1,2-Dichloroethene	100	100	0.02	0.02	0.02	0.02	0.02	0.02	0.05	0.02	A6R (bkd)	None	0.02	0.02	0.04
1,2-Dichloropropane	5	5	0.08	0.08	0.08	0.08	0.08	0.08	0.61	0.60	A6R (bkd)	A6R (bkd)	0.08	0.08	0.16
Ethylbenzene	700	700	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	None	None	0.04	0.04	0.08
Methyl Ethyl Ketone	- -	- -	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	None	None	2.48	2.48	4.95
Methyl Isobutyl Ketone	- -	- -	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	None	None	0.95	0.95	1.89
Methylene Chloride	5	5	0.03	0.03	0.03	0.03	0.03	0.03	0.44	0.47	A6R (bkd)	A6R (bkd)	2.86	0.03	0.06
Naphthalene	- -	28	0.13	0.13	0.13	0.13	0.13	0.13	0.41	0.13	A6R (bkd)	None	0.13	0.13	0.26
Tetrachloroethene	5	5	0.04	0.04	0.50	0.43	1.40	0.70	0.53	0.50	A1,A5,A6R(bkd)	A1,A5,A6R(bkd)	0.04	0.04	0.08
1,1,1-Trichloroethane	200	200	0.06	0.02	0.02	0.02	0.02	0.02	0.02	0.02	None	None	0.02	0.02	0.03
Toluene	1000	1000	0.05	0.05	0.07	0.05	0.05	0.05	0.06	0.05	None	None	0.08	0.05	0.1
Trichloroethene	5	5	0.06	0.06	0.18	0.06	0.28	0.14	0.59	0.61	A1,A5,A6R(bkd)	A5,A6R (bkd)	0.06	0.06	0.12
Trichlorofluoromethane	- -	10000	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.07	None	None	0.07	0.07	0.14
Vinyl Chloride	2	0.15	0.15	0.15	0.15	0.15	0.15	0.15	3.38	3.35	A6R (std)	A6R (std)	0.15	0.15	0.3
m+p Xylenes	10000	10000	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.07	None	None	0.07	0.07	0.14
o-Xylene	10000	10000	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	None	None	0.03	0.04	0.07
			n= 29		n= 31		n= 19		n= 16				n= 3		
1,2-Dichlorobenzene-8270	600	600	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	None	None	0.53	0.53	1.07
1,4-Dichlorobenzene-8270	75	75	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	None	None	0.64	0.64	1.27
Diethylphthalate	- -	5600	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	None	None	0.37	0.37	0.73
Di-n-butylphthalate	- -	2700	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	None	None	0.29	0.29	0.57
Di-n-octylphthalate	- -	- -	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	None	None	0.41	0.41	0.82
bis(2-ethylhexyl)phthalate	6	6	0.39	0.39	0.54	0.39	1.19	0.39	1.36	0.39	A1,A5,A6R(bkd)	None	0.39	0.39	0.77
Acenaphthene	- -	420	0.29	0.29	0.29	0.29	0.29	0.29	0.34	0.29	A6R (bkd)	None	0.29	0.29	0.58
1-Methylnaphthalene	- -	- -	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	None	None	0.40	0.40	0.80
2-Methylphenol	- -	- -	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	None	None	0.37	0.37	0.73
4-Methylphenol/3-Methylpheno	- -	- -	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	None	None	0.30	0.30	0.60
Phenol	- -	300	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	None	None	0.34	0.34	0.67
			n= 25		n= 27		n= 18		n= 15				n= 1		
Picloram	500	500	0.070	0.002	0.002	0.002	0.177	0.002	0.021	0.002	A5, (bkd)	None	0.002	0.002	0.003
2,4,5-T	50	70	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	None	None	0.002	0.002	0.003
2,4-D	70	70	0.011	0.011	0.011	0.011	0.017	0.011	0.011	0.011	A5, (bkd)	None	0.011	0.011	0.023
4-Nitrophenol	- -	56	0.017	0.005	0.005	0.005	0.005	0.005	0.005	0.005	None	None	0.005	0.005	0.009
Dacthal	- -	70	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	None	None	0.0004	0.0004	0.0009
Pentachlorophenol	1	1	0.004	0.004	0.009	0.004	0.004	0.004	0.004	0.004	A1 (bkd)	None	0.004	0.004	0.007

BDL values calculated as equal to one-half the method detection limit (MDL)

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Waste & Underground
Tank Management Bureau

Old Butte landfill Cu
ground water file

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BUTTE-SILVER BOW LANDFILL/CLARK TAILINGS CORRECTIVE MEASURES ASSESSMENT

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Montana Department of Health
and Environmental Sciences
Waste Management Division

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DRAFT

BUTTE-SILVER BOW LANDFILL/CLARK TAILINGS CORRECTIVE MEASURES ASSESSMENT

Prepared for:

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MAY 1995

EXECUTIVE SUMMARY

On December 23, 1994, a letter was received by Gary Keeler of Butte-Silver Bow County (BSB) from Pat Crowley of the Montana Department of Health and Environmental Sciences (MDHES) Solid Waste Program notifying BSB that the Fourth Quarter groundwater monitoring results for the Old Butte Sanitary Landfill exceeded the groundwater protection standards for certain constituents of concern listed on Table 2 of Administrative Rules of Montana Title 16, Chapter 14, Subchapter 7, Section 8 (ARM 16.14.708). In the same letter, MDHES notified BSB that additional sampling was required to be conducted during the first quarter of 1995 and that preparation of a Corrective Measures Assessment was to be completed. This document was prepared to specifically satisfy these requirements.

Pursuant to the agreement reached between MDHES, the U. S. Environmental Protection Agency (EPA), BSB, Inland Properties, Inc., and the Atlantic Richfield Company (ARCO), the Old Butte-Silver Bow Sanitary Landfill and the adjacent Clark Tailings will be addressed as one unit, since the two sites are contiguous and have the same anticipated end land use.

The objective of this assessment of corrective measures is to identify viable alternatives that will minimize potential threats to human health and the environment. The site history, setting, and available data are presented and analyzed. Remedial technologies are identified and screened. Then, technologies are organized into viable alternatives, which are screened and then evaluated in detail.

The Old Butte-Silver Bow Landfill is located approximately one mile southwest of the city of Butte and covers approximately 67 acres. The landfill opened in approximately 1968 and accepted the municipal solid waste from Butte and it's vicinity. The landfill was issued an operating license by the MDHES in 1978. The landfill stopped receiving municipal solid (Group II) wastes from the public on March 14, 1994 (with the opening of the new Butte-Silver Bow Sanitary Landfill). Some construction and demolition debris is still disposed at the site by Butte-Silver Bow contractors, as approved by MDHES. In the summer of 1994, final cover installation, in accordance with the landfill's closure plan, was started. At the end of the 1994 construction season, an estimated 37 of the 67 acres requiring closure had received final cover.

The Clark Tailings cover approximately 60 acres and lie to the east of the Old Butte-Silver Bow Landfill. The source of the Clark Tailings was the Timber Butte Mill, which began operation in 1914 and was dismantled in 1948. The Clark Tailings were reclaimed in the mid-1980's as part of the "Clark Tailings Erosion Control Project", by the Anaconda Minerals Company. While much of area was regraded, covered, and revegetated, there are many areas where tailings are currently present at the surface. There is not an adequate depth of cover soil in portions of the area to adequately sustain vegetative growth.

Future land use plans for the Old Butte-Silver Bow Landfill/Clark Tailings site are outlined in the BSB Land Use Master Plan. The future land use is designated as open space/recreational. Current zoning precludes residential development on the site. The recreational uses may specifically include the development of athletic fields, park settings, golfing, and other outdoor recreational facilities.

Groundwater monitoring at the site has detected the presence of contaminants at concentrations exceeding groundwater protection standards in wells beneath the site. Based on statistical analyses, cadmium; iron; zinc; sulfate; 1,1-dichloroethane; cis-1,2-dichloroethene; tetrachloroethene; trichloroethene; and vinyl chloride have been identified as contaminants of concern (CoC) that have exceeded groundwater protection standards in landfill monitoring wells. However, sampling of water supply wells downgradient of the site have not detected CoC at concentrations exceeding groundwater protection standards. Based on available information, groundwater protection standards have not been exceeded beyond the point of compliance. Nonetheless, as a result of the detection of constituents above the groundwater protection standard, this corrective measures assessment was prepared.

Preliminary remediation goals for the site are defined primarily by solid waste regulations. Landfill closure regulations at ARM 16.14.530 (for portions of the site which received wastes after October 9, 1991) and MDHES guidance (or portions of the site that stopped receiving wastes prior to October 9, 1991) contain provisions governing landfill capping. Groundwater protection standards for the site are defined at ARM 16.14.708(5) and require that groundwater protection standards are not exceeded at or beyond the point of compliance. The point of compliance is defined as the a point not more than 150 meters downgradient of the waste management unit and on property owned by the owner of the waste management unit.

Based on the available information, reclamation technologies and process options applicable to the site were identified and screened. Remaining technologies and process options were assembled into alternatives, which were developed, analyzed, and evaluated based on effectiveness, implementability, and cost. Results of the analysis are summarized on Table ES-1.

Additional data are required to select a remedy. These data include:

- continued groundwater monitoring to establish a statistically significant number of measurements;
- adding downgradient groundwater monitoring wells to the groundwater monitoring program;
- characterizing the waste source to better define the contamination source;
- determine downgradient groundwater uses;
- determine cover soil properties, including revegetation parameters; and
- update the topographic survey and the final closure plan.

Before the selection and implementation of a preferred alternative, interim measures may be employed to fill data gaps identified above to assist in the selection of a preferred alternative. Also, capping of the landfill to satisfy landfill closure requirements will continue as an interim measure.

After additional data is gathered, the remaining alternatives will be re-evaluated based on criteria identified in ARM 16.14.708(7), which is consistent with the National Contingency Plan. A remedy will be selected and the public notified. The public will be given an opportunity to comment on the selected remedy. Then, the remedy design will be finalized, and the remedy will be implemented in a timely and cost-effective manner.

TABLE ES-1: ALTERNATIVE SCREENING SUMMARY

ALTERNATIVE	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING SUMMARY
1. No Action	No additional action is taken at the site. Site would remain with landfill only partially capped and Clark Tailings cap partially eroding.	Protection of human health and the environment is not achieved. Not effective at satisfying landfill closure requirements.	Not applicable.	There is no cost associated with this alternative.	This alternative will be retained for comparison of other alternatives as suggested by the NCP.
2. Institutional Controls	A fence would be installed around the site to prevent access. Land and groundwater use restrictions would be implemented.	Not effective at satisfying landfill closure regulations. Effective at minimizing exposure to CoC.	Access restrictions implementable, but contradict with community's end use plans for the site.	Present worth value of $541,000, includes $189,000 in capital costs and $37,400 in annual O&M costs.	This alternative will not be considered further as a stand alone alternative.
3. Native Materials Capping	Native materials caps installed to satisfy landfill closure regulations. Run-on/runoff controls installed. Long-term groundwater monitoring.	Effective at satisfying landfill closure regulations and preventing direct contact. Decrease amount of surface water infiltration through wastes.	Technically and administratively feasible. Compatible with final use plans. Not known if alternative will adequately address existing groundwater contamination.	Present worth value of $1,413,000, includes $1,040,000 in capital costs and $40,00 in annual O&M costs.	Alternative is implementable and potentially effective; it will be retained for further consideration.
4. Native Materials Capping with Institutional Controls	Land and groundwater use restrictions implemented in addition to native materials cap described in Alternative 3.	Effective at satisfying landfill closure regulations and preventing exposure to CoC.	Technically implementable. Implementation of controlled groundwater use zone will require agreement of affected groundwater users.	Present worth value of $1,482,000 includes $1,109,000 in capital costs and $40,000 in annual O&M costs.	Alternative is effective and implementable; it will be retained for further consideration.
5. Multimedia capping	A multimedia cap, consisting of native soils, a geosynthetic clay liner, and a flexible membrane liner would be installed to minimize infiltration through wastes. Institutional controls may also be implemented to control groundwater use.	Effective at preventing contact with CoC and minimizing surface water infiltration. Not certain if alternative would be effective at addressing groundwater contamination.	Technically and administratively implementable.	Present worth value of $7,945,000 includes $7,500,000 in capital costs and $47,000 in annual O&M costs. Present worth rises to $8,015,000 if institutional controls are added.	Alternative is potentially effective and implementable. However, due to high cost and uncertain effectiveness, this alternative will not be retained for further analysis.

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1.0 INTRODUCTION

On December 23, 1994, a letter was received by Gary Keeler of Butte-Silver Bow County (BSB) from Pat Crowley of the Montana Department of Health and Environmental Sciences (MDHES) Solid Waste Program notifying BSB that the Fourth Quarter groundwater monitoring results for the Old Butte-Silver Bow Sanitary Landfill (hereafter referred to as the "Old Landfill") exceeded the groundwater protection standards for certain constituents of concern listed on Table 2 of Administrative Rules of Montana Title 16, Chapter 14, Subchapter 7, Section 8 (ARM 16.14.708)(see Attachment 1). In the same letter, MDHES notified BSB that additional sampling was required to be conducted during the first quarter of 1995 and that preparation of a Corrective Measures Assessment was to be completed. This document was prepared to specifically satisfy these requirements. Additionally, the letter suggested combining the closure of the Old Landfill with the Clark Tailings since the two sites are contiguous and have the same anticipated end land use. Therefore, pursuant to the agreement reached between MDHES, the U.S. Environmental Protection Agency (EPA), BSB, Inland Properties, and the Atlantic Richfield Company (ARCO), the Old Landfill and the adjacent Clark Tailings will be addressed as one contiguous unit.

1.1 ASSESSMENT RATIONALE

This Corrective Measures Assessment (CMA) addresses the Old Landfill and the adjacent Clark Tailings. The Old Landfill/Clark Tailings site is located in portions of Sections 25, 26, 35, and 36 of Township 3 North, Range 8 West in Butte-Silver Bow County, Montana (Figure 1-1). The purpose of this CMA is to summarize available information and consider potential corrective measures for these two adjacent sites.

The Clark Tailings are located immediately east of the Old Landfill (Figure 1-1). Based on letters received from EPA and MDHES (Attachments 2 and 3), the Clark Tailings are no longer considered a part of the Butte Priority Soils Operable Unit (BPSOU) of the Silver Bow Creek/Butte Area National Priorities List (NPL) site. However, remediation of the sites will be consistent with the goals and objectives of the Superfund process. Both Superfund divisions of EPA and MDHES will provide concurrence with the selected remedy for the site and the selected remedy will be addressed as a "completed" site in the BPSOU Record of Decision. The Clark Tailings were reclaimed in the 1980's by the Anaconda Company under the Clark Tailings Erosion Control Project. However, final land-use for the site was not resolved at that time.

The corrective measures at both the Old Landfill and the Clark Tailings must consider future land use plans for the sites, which are detailed in the BSB Land Use Master Plan. The plan designates the area as open space/recreational.

The objective of this assessment of corrective measures is to identify viable alternatives that will minimize potential threats to human health and the environment. The site history, setting, and available data are presented and analyzed. Next, remedial technologies are identified and screened. Then, technologies are organized into viable alternatives, which are screened and then

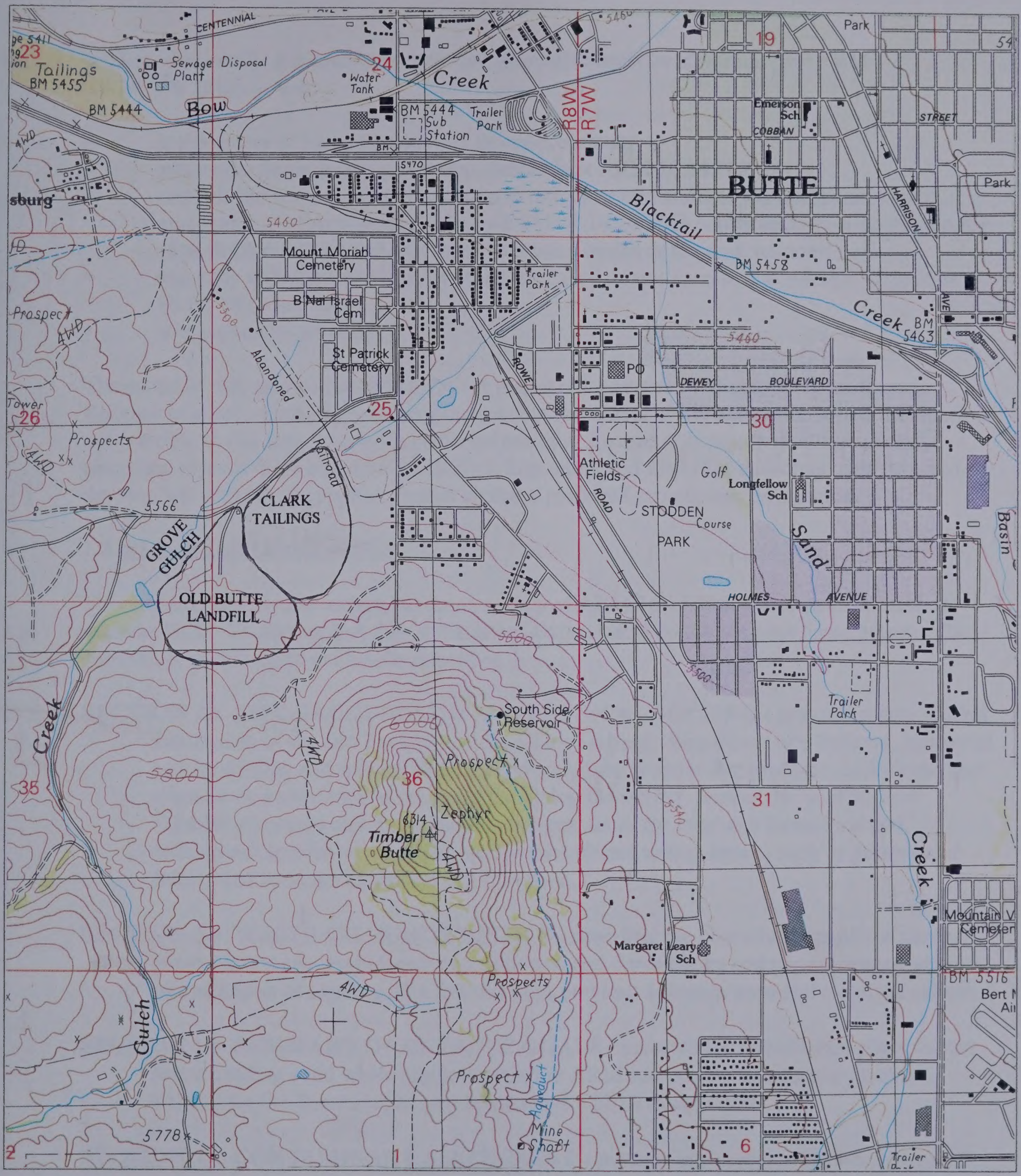
CENTENNIAL
Tailings
BM 5455
Sewage Disposal Plant
Water Tank
Bow
Creek
BM 5444
Sub Station
Trailer Park
R8W
R7W
Emerson Sch
COBBAN
STREET
BUTTE
Park
HARRISON
Blacktail
BM 5458
Creek
BM 5463
Mount Moriah Cemetery
B Nai Israel Cem
St Patrick Cemetery
Abandoned
Railroad
ROWE
PO
DEWEY
BOULEVARD
Athletic Fields
ROAD
Golf
Longfellow Sch
STODDEN
Course
PARK
Sand
HOLMES
AVENUE
CLARK TAILINGS
GROVE GULCH
OLD BUTTE LANDFILL
Prospect
Prospects
Tower
4WD
5566
South Side Reservoir
Timber Butte
6314
Zephyr
Creek
Basin
Trailer Park
Mountain View Cemetery
Margaret Leary Sch
Aqueduct
Mine Shaft
Gulch
5778
BM 5516
23
24
19
25
26
30
35
36
31
1
2
6

FIGURE 1-1
SITE VICINITY MAP
OLD BUTTE LANDFILL

N

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SCALE: 1" = 24,000"

USGS 7 1/2 Minute Quadrangle, Butte South, MT

evaluated in detail. Ultimately, a preferred alternative must be identified [per ARM 16.14.708(7)(b)], which:

- is protective of human health and the environment;
- attains the groundwater protection standards at ARM 16.14.708(5);
- controls the sources of releases so as to reduce or eliminate, to the maximum extent practicable, further releases of Table 2 [ARM 16.14.706] constituents of concern into the environment that may pose a threat to human health or the environment;
- complies with the standards for management of wastes specified at ARM 16.14.708(8)(d); and
- is approved by MDHES.

The scope of this report is slightly different than a full assessment of corrective measures. Because of a lack of information pertaining to the full extent of the contamination at the site, it is not possible at this time to select a preferred remedy. Instead, this report identifies potential remedies, screens them based on available information, and identifies additional data required to develop and analyze alternatives further so that a preferred remedy can be selected.

1.2 REPORT ORGANIZATION

This CMA is designed to satisfy the requirements of ARM 16.14.708(6) and to be consistent with the NCP. To accomplish this, it has been is organized into the sections listed below. The contents of each section are briefly described .

SECTION 2.0 SITE BACKGROUND AND PHYSICAL SETTING - presents a background description of the Old Landfill and the Clark Tailings. Significant site features; history of past landfilling and tailings disposal and reclamation activities; geologic, hydrologic and climatic characteristics of the sites; the biological setting, such as the wildlife and fisheries resources and the vegetation indigenous to the area; and threatened and endangered species concerns, as well as the cultural setting issues, such as present and future land uses, are described in this section.

SECTION 3.0 WASTE CHARACTERISTICS - describes the characteristics of the wastes present at the site, including types, volumes, and contaminant concentrations, as well as an evaluation of existing data derived from previous investigations and response actions.

SECTION 4.0 SUMMARY OF CLEANUP GOALS - presents the remediation goals for the site, including solid waste regulations in the ARM and other performance standards utilized for the Butte area as part of previous CERCLA activities.

SECTION 5.0 CONTAMINANT ASSESSMENT - presents and analyzes the environmental data available for the site and identifies CoC. Where appropriate, the effect of cleanup standards discussed in Section 4.0 on the objectives of the corrective measures is discussed.

SECTION 6.0 DEVELOPMENT AND SCREENING OF REMEDIATION ALTERNATIVES - identifies and screens potentially applicable remediation alternatives. Alternatives are evaluated and screened based on the requirements of ARM 16.14.708.

SECTION 7.0 INTERIM MEASURES ANALYSIS - presents an analysis of interim measures that may be taken that would consistent with the objectives of the remediation and would reasonably contribute to the selected remedy, in accordance with ARM 16.14.708(8)(a)(iii).

SECTION 8.0 CORRECTIVE MEASURES ASSESSMENT TASKS - identifies the additional site characterization tasks that are necessary to adequately characterize the nature and extent of the contamination, as well as the physical setting, to support a detailed evaluation of remediation alternatives and the ultimate remediation design.

SECTION 9.0 DATA QUALITY OBJECTIVES - identifies the data quality objectives for the site characterization effort described in Section 8.0.

SECTION 10.0 DATA MANAGEMENT PLAN - describes the manner in which data collected as part of the site characterization effort will be validated and managed.

SECTION 11.0 PROCEDURES FOR THE DETAILED ANALYSIS OF RECLAMATION ALTERNATIVES - describes the procedures used to conduct the detailed analysis of remediation alternatives and select a preferred alternative in accordance with ARM 16.14.708.

SECTION 12.0 PROJECT SCHEDULE - presents the proposed project schedule.

SECTION 13.0 DELIVERABLES - describes the project deliverables and milestones necessary to meet the proposed project schedule.

SECTION 14.0 PROJECT MANAGEMENT PLAN - details how the project will be managed and tracked from the completion of CMA through construction of the selected remedial alternative and post-construction monitoring.

SECTION 15.0 COMMUNITY RELATIONS PLAN - describes how the community will be involved in the selection of the preferred alternative and informed of project progress, in accordance with the requirements of ARM 16.14.708(6)(d).

SECTION 16.0 REFERENCES - provides references for technical and regulatory citations in the document.

2.0 SITE BACKGROUND AND PHYSICAL SETTING

2.1 SITE HISTORY

2.1.1 Old Landfill Site

The Old Landfill is located approximately one mile southwest of the city of Butte (Figure 1-1). The landfill is located at approximately 45° 58' 38" North latitude and 112° 33' 05" West longitude. Covering approximately 67 acres, it lies within portions of the SE¼ of Section 26, the SW¼ of Section 25, the NE¼ and the NW¼ of Section 35, and the NW¼ of Section 36 of Township 3 North, Range 8 West in Silver Bow County, Montana.

The Old Landfill opened in approximately 1968 and accepted the municipal solid waste from Butte and it's vicinity. The landfill was issued an operating license by the MDHES in 1978 (a permit was not required previously). Since 1978, the landfill has been inspected on a regular basis by MDHES personnel.

Landfilling at the site appears to have used a combination of area and trench landfilling methods.

Grove Gulch historically flowed through the northwestern portion of the site. In the early 1980's, a sedimentation basin was constructed immediately west of the Old Landfill by the U.S. Department of Agriculture Soil Conservation Service (SCS). Discharge from the sedimentation basin was routed generally north of the historic drainage, along the northwest boundary of the landfilled area (Figure 2-1). At the point where the native drainage meets Little Basin Creek Road (near the northern border of the landfill, see Figure 2-1), Grove Gulch enters a 42-inch diameter reinforced concrete pipe (RCP) culvert, which carries the flow underground until it discharges on the eastern side of the old Burlington Northern Railroad grade, approximately 1,700 feet northeast of the Old Landfill and immediately east of the Clark Tailings.

Runoff from the Clark Tailings and the eastern portion of the Old Landfill is conveyed, via a constructed ditch between the tailings and the landfill, to the Timber Butte Sedimentation Basin, located in the northeastern portion of the Clark Tailings site (see Figure 2-1). This basin is dewatered by a 36-inch diameter, perforated RCP riser. The basin was designed to allow for the sedimentation of solids from the Timber Butte Mill Site, surrounding adjacent lands, and the Clark Tailings during runoff events. The perforated riser connects to the RCP diversion of Grove Gulch discussed above. The drop inlet and ditch were also constructed in the early to mid-1980's.

The Old Landfill stopped receiving municipal solid (Group II) wastes from the public on March 14, 1994 (with the opening of the new Butte-Silver Bow Sanitary Landfill). Some construction and demolition debris is still disposed at the site by Butte-Silver Bow contractors, as approved by MDHES (Attachment 4). The construction and demolition debris disposal area is shown on Figure 2-2. The public has not had access to the site for refuse disposal since March 14, 1994.

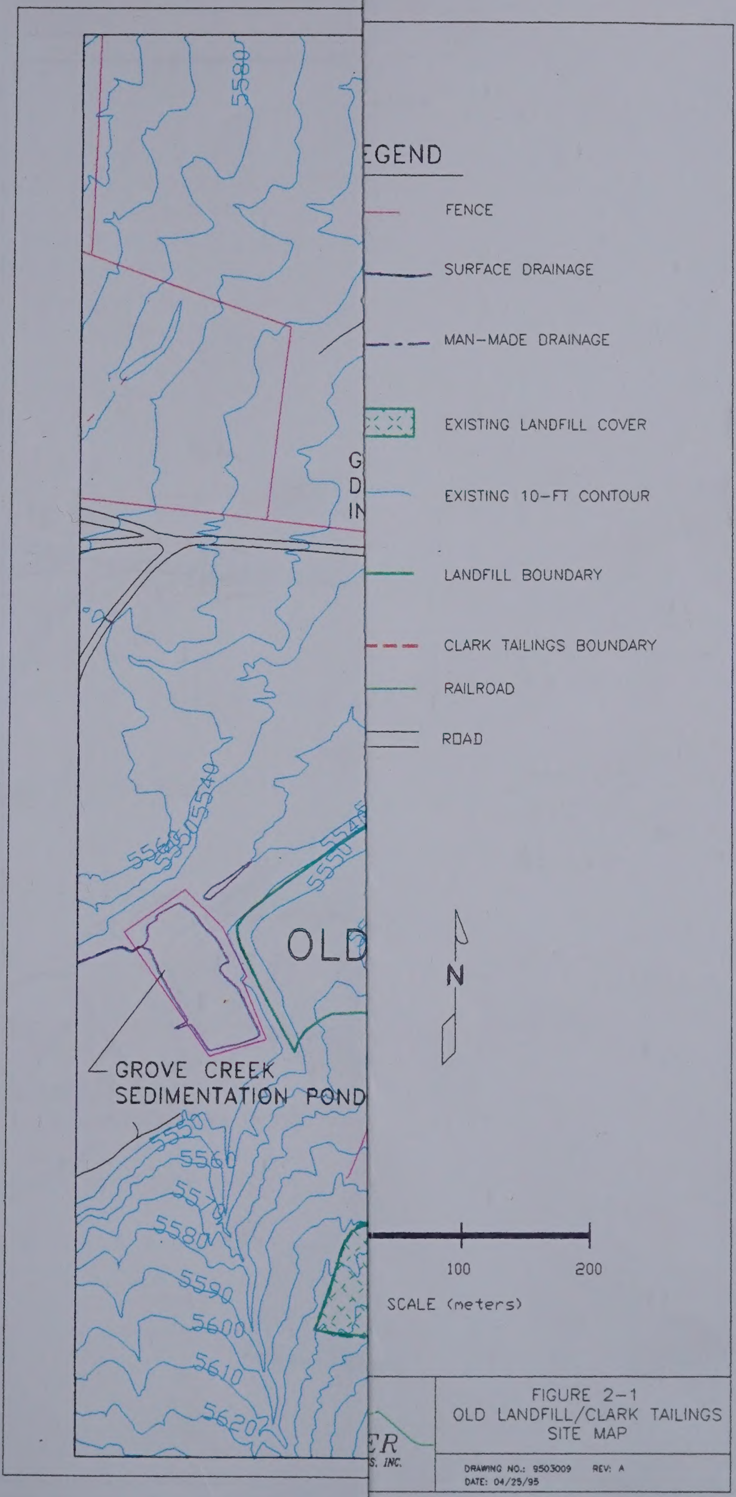
5580
EGEND
FENCE
SURFACE DRAINAGE
MAN-MADE DRAINAGE
EXISTING LANDFILL COVER
EXISTING 10-FT CONTOUR
LANDFILL BOUNDARY
CLARK TAILINGS BOUNDARY
RAILROAD
ROAD
G
D
IN
5540
5560
5550
5545
OLD
N
GROVE CREEK
SEDIMENTATION POND
5550
5560
5570
5580
5590
5600
5610
5620
100
200
SCALE (meters)
ER
S. INC.

FIGURE 2-1
OLD LANDFILL/CLARK TAILINGS
SITE MAP

DRAWING NO.: 9503009 REV: A
DATE: 04/25/95

2.0 SITE BACKGROUND AND PHYSICAL SETTING

2.1 SITE HISTORY

2.1.1 Old Landfill Site

The Old Landfill is located approximately one-half mile north-northeast of the city of Butte (Figure 1-1). The landfill is located at approximately 46°03'38" North latitude and 112°31'30" West longitude. Covering approximately 67 acres, it lies within portions of the SE¼ of Section 26, the SW¼ of Section 25, the NE¼ and the NW¼ of Section 35, and the NW¼ of Section 36 of Township 3 North, Range 8 West, Silver Bow County, Montana.

The Old Landfill opened in approximately [illegible] and accepted about [illegible] solid waste from Butte and surrounding areas. The landfill was issued an operating license by the MDHES in 1972 (a permit was not required previously). Since 1972, the landfill has been inspected on a regular basis by MDHES personnel.

Landfilling at the site appears to have used a combination of area and trench landfilling methods. Grove Gulch historically flowed through the northwestern portion of the site. In the early 1980's, a sedimentation basin was constructed immediately west of the Old Landfill by the U.S. Department of Agriculture Soil Conservation Service (SCS). Grove Gulch flows from the sedimentation basin generally north [illegible] along the northwestern boundary of the landfill. At the point where the northwest [illegible] Grove Gulch [illegible] Road (near the northern border of the landfill, see Figure 2-1), Grove Gulch enters a 48-inch diameter reinforced concrete pipe (RCP) culvert which carries the flow underground until it discharges on the eastern side of the old Northern Pacific Railroad grade, approximately 1,700 feet northeast of the Old Landfill and immediately east of the Clark Tailings.

Runoff from the Clark Tailings and the upper portions of the Old Landfill is conveyed, via a constructed ditch between the tailings and the landfill, to the Timber Butte Sedimentation Basin, located in the southwestern portion of the Clark Tailings (see Figure 2-1). It was [illegible] designed by a [illegible] (depicted on Figure 2-2). The basin was designed and [illegible] for the sedimentation of solids from the Timber Butte Mill Site, surrounding adjacent lands, and the Clark Tailings during runoff events. The pipe outlet then connects to the RCP diversion of Grove Gulch discussed above. The design for the [illegible] in the early 1980s.

The Old Landfill stopped receiving municipal solid (Group II) wastes from the public on March 14, 1994 with the opening of the new Butte-Silver Bow landfill. However, construction and demolition debris is still deposited at the site by Butte-Silver Bow contractors, as approved by MDHES (Attachment 4). The construction and demolition debris disposal area is shown on Figure 2-2. The public has not had access to the site for refuse disposal since March 14, 1994.

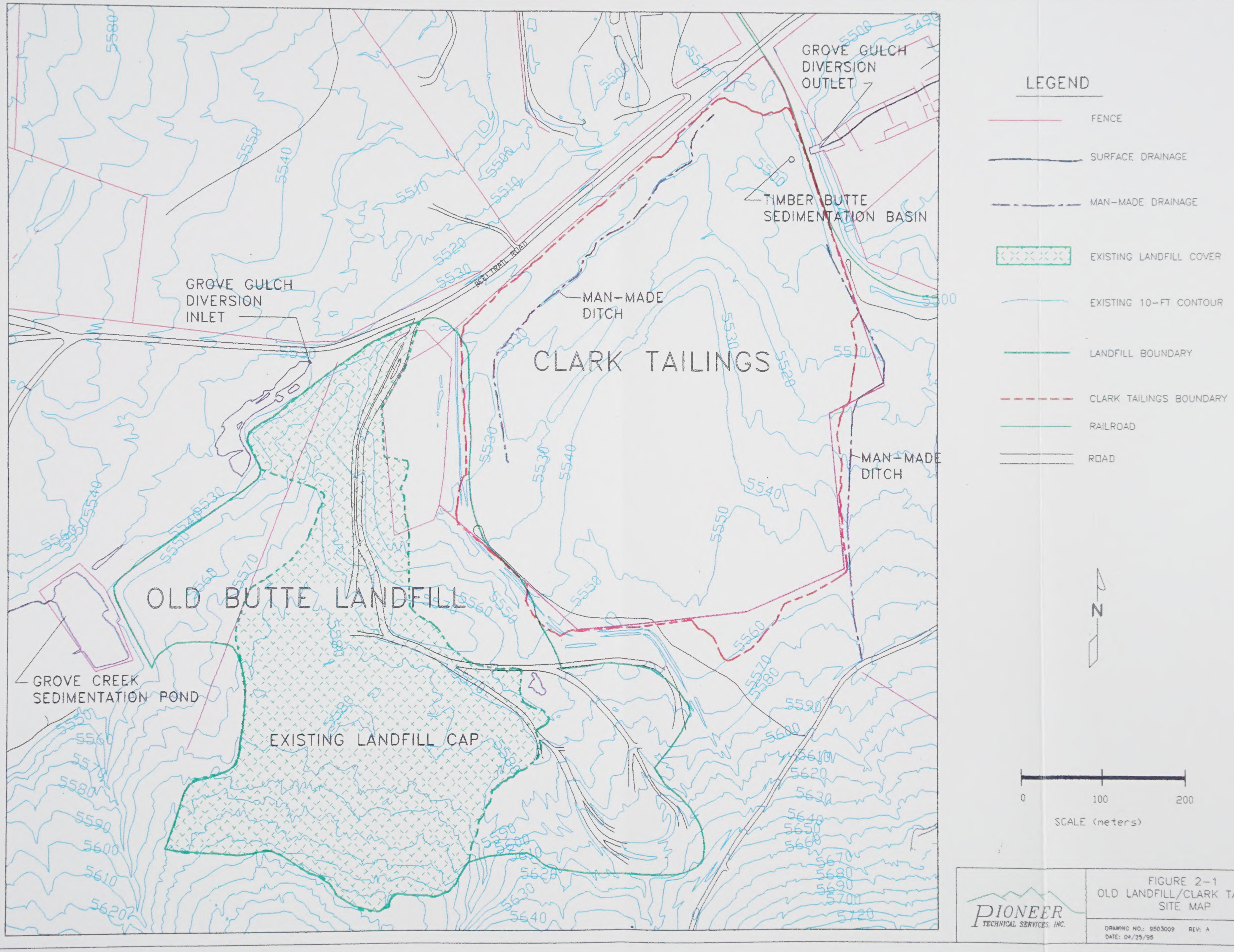
GROVE GULCH
DIVERSION
OUTLET
TIMBER BUTTE
SEDIMENTATION BASIN
GROVE GULCH
DIVERSION
INLET
MAN-MADE
DITCH
CLARK TAILINGS
MAN-MADE
DITCH
OLD BUTTE LANDFILL
GROVE CREEK
SEDIMENTATION POND
EXISTING LANDFILL CAP
BELT TRAIL ROAD
LEGEND
FENCE
SURFACE DRAINAGE
MAN-MADE DRAINAGE
EXISTING LANDFILL COVER
EXISTING 10-FT CONTOUR
LANDFILL BOUNDARY
CLARK TAILINGS BOUNDARY
RAILROAD
ROAD
N
0
100
200
SCALE (meters)

FIGURE 2-1
OLD LANDFILL/CLARK TAILINGS
SITE MAP

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DRAWING NO.: 9503009 REV: A
DATE: 04/25/95

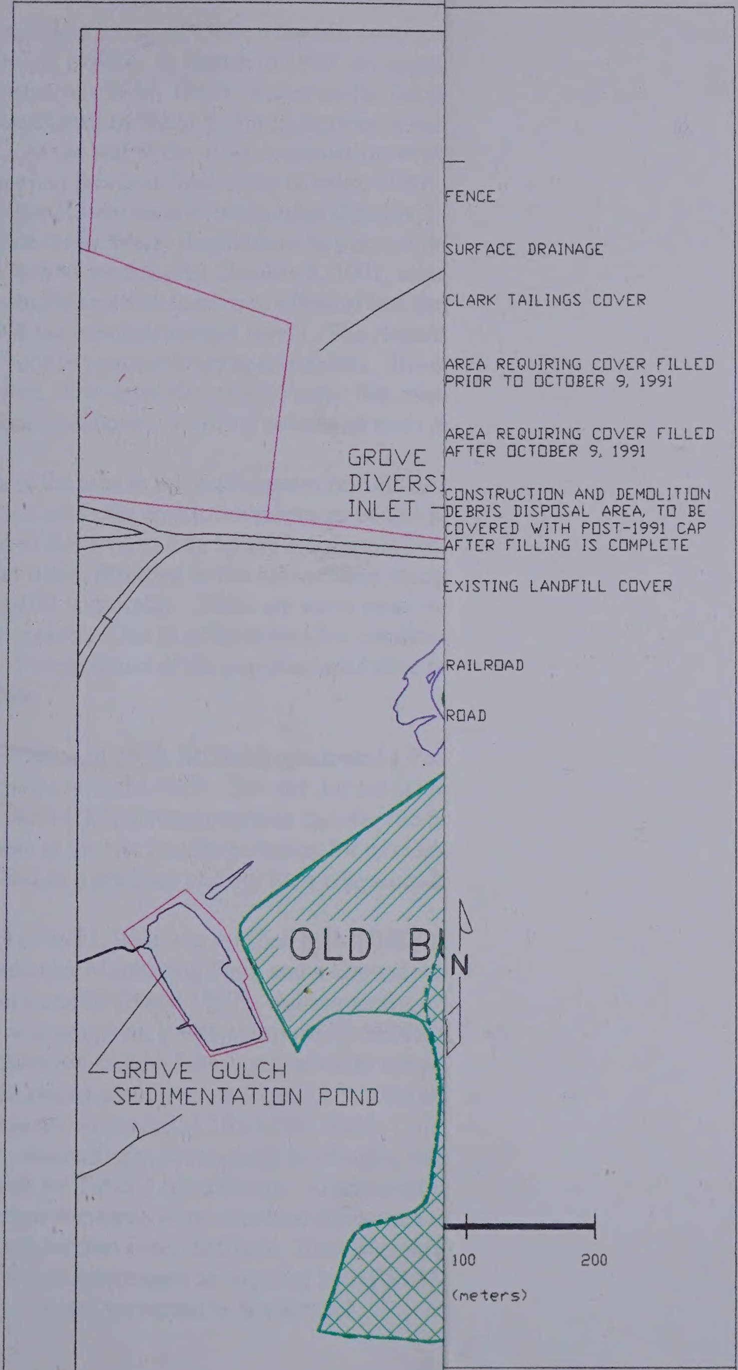
FENCE
SURFACE DRAINAGE
CLARK TAILINGS COVER
AREA REQUIRING COVER FILLED PRIOR TO OCTOBER 9, 1991
AREA REQUIRING COVER FILLED AFTER OCTOBER 9, 1991
CONSTRUCTION AND DEMOLITION DEBRIS DISPOSAL AREA, TO BE COVERED WITH POST-1991 CAP AFTER FILLING IS COMPLETE
EXISTING LANDFILL COVER
RAILROAD
ROAD
GROVE
DIVERSI
INLET
OLD B
N
GROVE GULCH
SEDIMENTATION POND
100
200
(meters)

FIGURE 2-2
OLD LANDFILL/CLARK TAILINGS
CAP BOUNDARIES

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DATE: 04/25/95

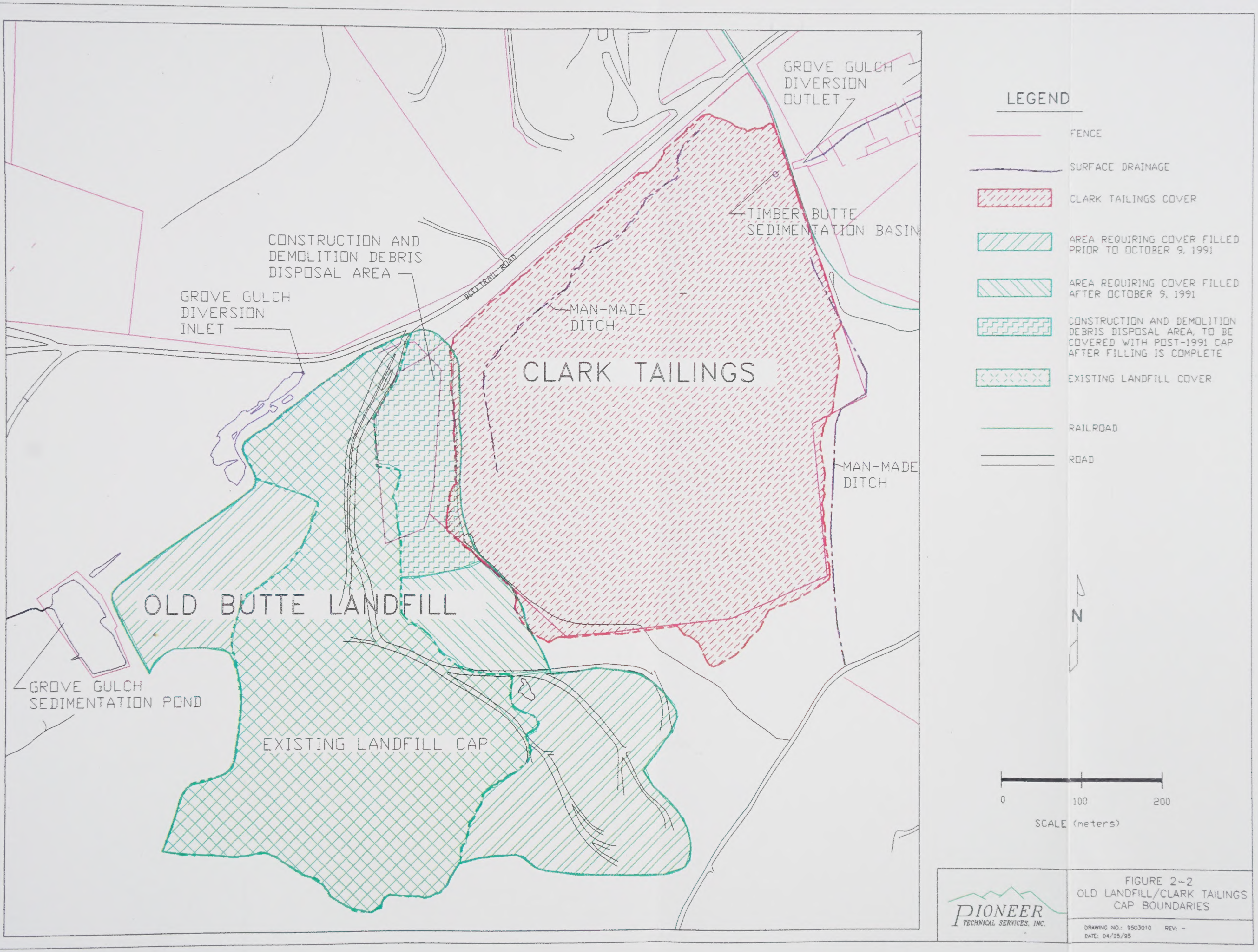

GROVE GULCH
DIVERSION
OUTLET
TIMBER BUTTE
SEDIMENTATION BASIN
CONSTRUCTION AND
DEMOLITION DEBRIS
DISPOSAL AREA
BEEF TRAIL ROAD
GROVE GULCH
DIVERSION
INLET
MAN-MADE
DITCH
CLARK TAILINGS
MAN-MADE
DITCH
OLD BUTTE LANDFILL
GROVE GULCH
SEDIMENTATION POND
EXISTING LANDFILL CAP
LEGEND
FENCE
SURFACE DRAINAGE
CLARK TAILINGS COVER
AREA REQUIRING COVER FILLED PRIOR TO OCTOBER 9, 1991
AREA REQUIRING COVER FILLED AFTER OCTOBER 9, 1991
CONSTRUCTION AND DEMOLITION DEBRIS DISPOSAL AREA, TO BE COVERED WITH POST-1991 CAP AFTER FILLING IS COMPLETE
EXISTING LANDFILL COVER
RAILROAD
ROAD
N
0
100
200
SCALE (meters)
PIONEER
TECHNICAL SERVICES, INC.
DRAWING NO.: 9503010 REV: -
DATE: 04/25/95

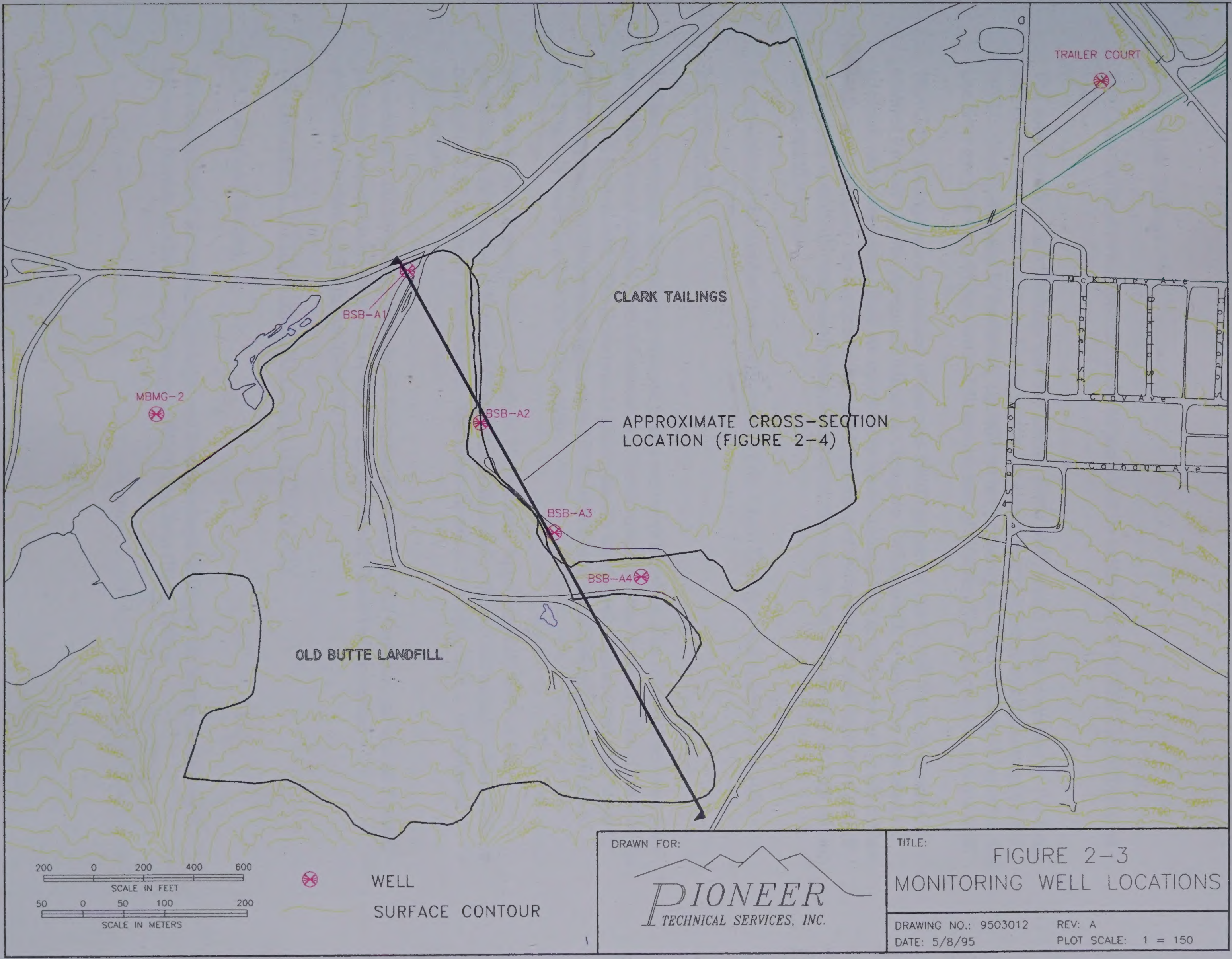
FIGURE 2-2
OLD LANDFILL/CLARK TAILINGS
CAP BOUNDARIES

In winter and spring of 1993, a landfill cover material evaluation was conducted (Braun-Intertec, 1993a and 1993b). In March of 1993, an Interim Closure Plan for the Butte-Silver Bow Landfill was prepared (SRM, 1993). Based on the information in these reports, installation of final cover was conducted by the U.S. Forest Service Anaconda Job Corps in the summers of 1993 and 1994. At the end of the 1994 construction work, an estimated 37 of the 67 acres requiring closure had received final cover (Keeler, 1994). The Interim Closure Plan had identified those areas that did not receive waste after October 9, 1991, and required a final cap in accordance with MDHES Solid Waste Regulations in place at that time (two feet of 1 x 10^{-3} cm/sec soils). Areas that received wastes after October 9, 1991, required closure in accordance with more stringent EPA regulations that came into effect at that time (18 inches of 1×10^{-5} cm/sec infiltration layer and 6 inches erosion control layer). The closure material evaluation showed that the soils met the 1×10^{-3} cm/sec permeability specification. The cap has been installed on much of this area (37 of 57 acres). The approximately 10 acres that received waste after October 9, 1991, has not received final cover. Existing cover and areas requiring cover are shown on Figure 2-2.

Much of the area in the southeastern portion of the Old Landfill is mounded; historic filling methods led to the erratic development of this portion of the landfill (no final cover has been placed in this area to date by the Job Corps). In this area, it appears that trenches were arbitrarily cut and filled, resulting in the inconsistent topography and drainages. Currently, vegetation over the landfill is sporadic. There are some areas with good vegetative cover, consisting primarily of bunch grasses. Due to adverse weather conditions, the cover placement was not completed in 1994. Revegetation of the cap is scheduled to be conducted following completion of all capping activities.

In November of 1990, MDHES conducted a Preliminary Assessment (PA) of the Old Landfill in accordance with the NCP. The site did not score high enough to be included as a Superfund site. However, MDHES recommended that the site be investigated further because of the lack of data available at the site and the potential for releases of hazardous substances. The site was classified as a medium priority for a screening-level site investigation.

In July of 1992, BSB was notified by MDHES that a Hydrogeological and Soils Study, a Groundwater Monitoring Plan, and a Groundwater Sampling and Analysis Plan were required at the Old Landfill (Potts, 1992). Subsequently, a work plan for the Hydrogeological and Soils Study was prepared; it was approved by MDHES on January 12, 1993 (Potts, 1993). The wells were installed and the initial groundwater sampling event was conducted in the spring of 1993. Well locations are shown on Figure 2-3. Ensuing groundwater sampling events detected constituents on the ARM 16.14.706, Table 1, list of analytes that exceeded specified action levels. Accordingly, assessment monitoring was conducted and subsequent samples were analyzed for Table 2 constituents. Assessment monitoring results showed that groundwater protection standards were exceeded for certain volatile organic compounds (VOCs) and, apparently at that time, thallium. Therefore, as previously stated, on December 23, 1994, this CMA became necessary as required by ARM 16.14.708(6) (see Attachment 1). Groundwater quality data are presented in Section 3.1.


TRAILER COURT
CLARK TAILINGS
BSB-A1
MBMG-2
BSB-A2
APPROXIMATE CROSS-SECTION LOCATION (FIGURE 2-4)
BSB-A3
BSB-A4
OLD BUTTE LANDFILL
McKinley Ave
Placer St
Dakota St
Colorado
Clay Ave
Calhoun Ave
Montana St
200 0 200 400 600
SCALE IN FEET
50 0 50 100 200
SCALE IN METERS
WELL
SURFACE CONTOUR

DRAWN FOR:

PIONEER TECHNICAL SERVICES, INC.

TITLE:

FIGURE 2-3
MONITORING WELL LOCATIONS

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REV: A
DATE: 5/8/95
PLOT SCALE: 1 = 150

2.1.2 Clark Tailings

The Clark Tailings cover approximately 60 acres and lie to the east of the Old Landfill (Figure 1-1).

The source of the Clark Tailings was the Timber Butte Mill, which began operation in 1914 and was dismantled in 1948. The mill was reportedly closed years before it was dismantled (Smith, 1953). During it's years of operation, the mill served primarily as a zinc and copper concentrator. Ore from the Elm Orlu Mine, north of Butte and east of Walkerville, was processed at the mill.

The Clark Tailings were reclaimed in the mid-1980's as part of the "Clark Tailings Erosion Control Project", by the Anaconda Minerals Company. While much of area was regraded, covered, and revegetated, there are many areas where tailings are currently present at the surface. There is not an adequate depth of cover soil in portions of the area to sustain vegetative growth. Also, there is evidence that runoff channels have cut through the cover materials into the tailings during runoff events.

Reclamation of the Timber Butte Mill, south of the Clark Tailings, was conducted in 1989.

2.2 CLIMATE

The climatological discussion presented in this section is based on data collected between 1906 and 1990 (Climatological Data, Montana, U.S. Environmental Data Service). The climate in the Butte area is semi-arid. The Butte area is known for it's short, cool summers and cold winters. The average annual temperature in Butte is 39° F, with a high mean monthly temperature of 63° F in July and a low of 15.5° F in January.

The average annual precipitation in Butte in 11.5 inches. Approximately 64% of the precipitation falls between May and September. Historically, the wettest month is June, with an average of 2.37 inches of precipitation. The driest month is February, with 0.38 inches of precipitation.

According to the Montana Agricultural Potential System (MAPS) database, the annual Penman potential evaporation at the site is 31 inches and the annual Thornwaite potential evapotranspiration is 19.4 inches (MAPS, 1995).

2.3 GEOLOGY, HYDROGEOLOGY, AND HYDROLOGY

2.3.1 Regional Setting

The discussion of the regional geologic and hydrogeologic setting of the site is based on a Montana Bureau of Mines and Geology (MBMG) bulletin (Botz, 1969).

Butte lies within the Summit Valley, which was formed in the Late Tertiary or Early Quaternary. Eroded materials from the uplands were deposited as quaternary alluvium (along the valley bottom) and colluvium (on upland slopes and hills) as the faulted Summit Valley basin dropped. This depositional material makes up the soils of the Summit Valley, including the area of the Old Landfill and the Clark Tailings. The sediments range from boulders to clay, ranges from 0 to 800 feet thick, and overlies bedrock. The lithology of the alluvium varies throughout the valley. Generally, as reconstructed from well logs and mine shafts in the area, the lithology consists of 50 to 100 feet of coarse-grained materials overlaying a fairly continuous layer of sandy silt or clay down to a depth of 100 feet below ground surface (bgs) in the area of the landfill (SRM, 1992). These sediments, particularly the clay and silt fractions, have the ability to adsorb and attenuate contaminants that come into contact with them.

Bedrock consists of igneous material associated with the Boulder Batholith (formed during the Cretaceous). Butte Quartz Monzonite (Qmp) constitutes the majority of bedrock under the Butte area, as well as most of the mountains and foothills surrounding the Summit Valley. The bedrock immediately below the alluvium/colluvium in the valley exhibits varying degrees of weathering, fracturing, and faulting. The competent bedrock below the weathered material is regarded as a relatively impermeable unit for all of Summit Valley. The bedrock aquifer has been demonstrated by ARCO to be a low permeability, low production aquifer that cannot be practicably used as a water source in the Summit Valley. This information is included in the Mine Flooding Operable Unit Record of Decision (EPA, 1994a).

Primary groundwater flow direction is patterned after the major surface drainage network in the valley. Depth to groundwater ranges from 11 to 300 feet bgs, with an average of approximately 50 feet (Botz, 1969). Hydraulic properties of the valley sediments are variable. Hydraulic conductivities in the valley are reportedly greatest in the alluvial sediments adjacent to the major surface drainages (Botz, 1969).

Significant, perennial surface water drainages in the Summit Valley are Blacktail Creek and Silver Bow Creek (below it's confluence with Blacktail Creek). Based on U.S. Geological Survey (USGS) Water Resources Data, Montana, 1984 to 1991, the mean discharge of Blacktail Creek, immediately before it's confluence with Silver Bow Creek, is 10.5 cubic feet per second (cfs). The mean discharge of Silver Bow Creek as it leaves Summit Valley is 22.5 cfs; a significant portion of this flow is the Butte Metro Sewage Treatment Plant discharge, which averages 7.3 cfs. Both of these streams are generally gaining streams through the Summit Valley (ESA, 1991). Grove Gulch, which is diverted around the site, is an intermittent stream which discharges to Blacktail Creek.

2.3.2 Local Geologic Setting

The Old Landfill/Clark Tailings site overlies the western flank of the Quaternary/Tertiary alluvial valley fill in the Summit Valley (Botz, 1969). The landfill monitoring well logs indicate that bedrock was encountered between 30 feet (A3, east) and 60 feet (A1, north) of the surface; no information is available for the Clark Tailings, but wells A4, A3, and A2 were drilled on the western and southern borders of the tailings and indicate that the entire tailings area is probably underlain by alluvium. The underlying bedrock is Cretaceous Butte Quartz Monzonite. Monitoring well locations are shown on Figure 2-3. A geologic cross-section based on these monitoring well logs is shown on Figure 2-4.

2.3.3 Local Hydrogeology

Although information regarding local hydrogeology is sparse, the Old Landfill probably overlies both the alluvial and bedrock groundwater systems. The northern portion of the landfill and probably most of the Clark Tailings influence the alluvial system. Local static water level measurements from domestic and irrigation wells taken concurrently with one of the landfill groundwater sampling rounds indicate that local groundwater flow travels along the former route (prior to its diversion to the east) of Grove Creek, toward the north-northeast (see Figure 2-5). Transmissivity was measured in the alluvial aquifer at 7,275 ft^2/day at a location 2 miles east-northeast of the landfill site (Botz, 1969).

2.3.4 Local Surface Hydrology

2.3.4.1 Local Drainage

The primary surface water feature in the vicinity of the site is Grove Gulch. This gulch historically cut across the northwest portion of the landfill property. After the landfill opened, a wooden culvert carried flow from Grove Gulch under the landfill and the adjacent Clark Tailings.

Grove Gulch is an intermittent stream draining approximately 4.4 square miles (2,800 acres) above the landfill. Most of this drainage basin is semi-arid upland range land. There are some areas disturbed by historic mining prospects. The peak flows associated on different return frequency flow events for this gulch are shown on Table 2-1. These flow values are based on USGS regional regression calculations (Omang, 1992). Note that these are estimated peak flows into the Grove Gulch Sedimentation Pond; peak discharges from the pond will be dampened as a result of the pond's detention capacity.

TABLE 2-1: ESTIMATED FLOOD FLOWS IN GROVE GULCH

RETURN FREQUENCY (years)	FLOW (cubic feet per second)
2	17.7
10	81.9
25	149
50	212
100	293

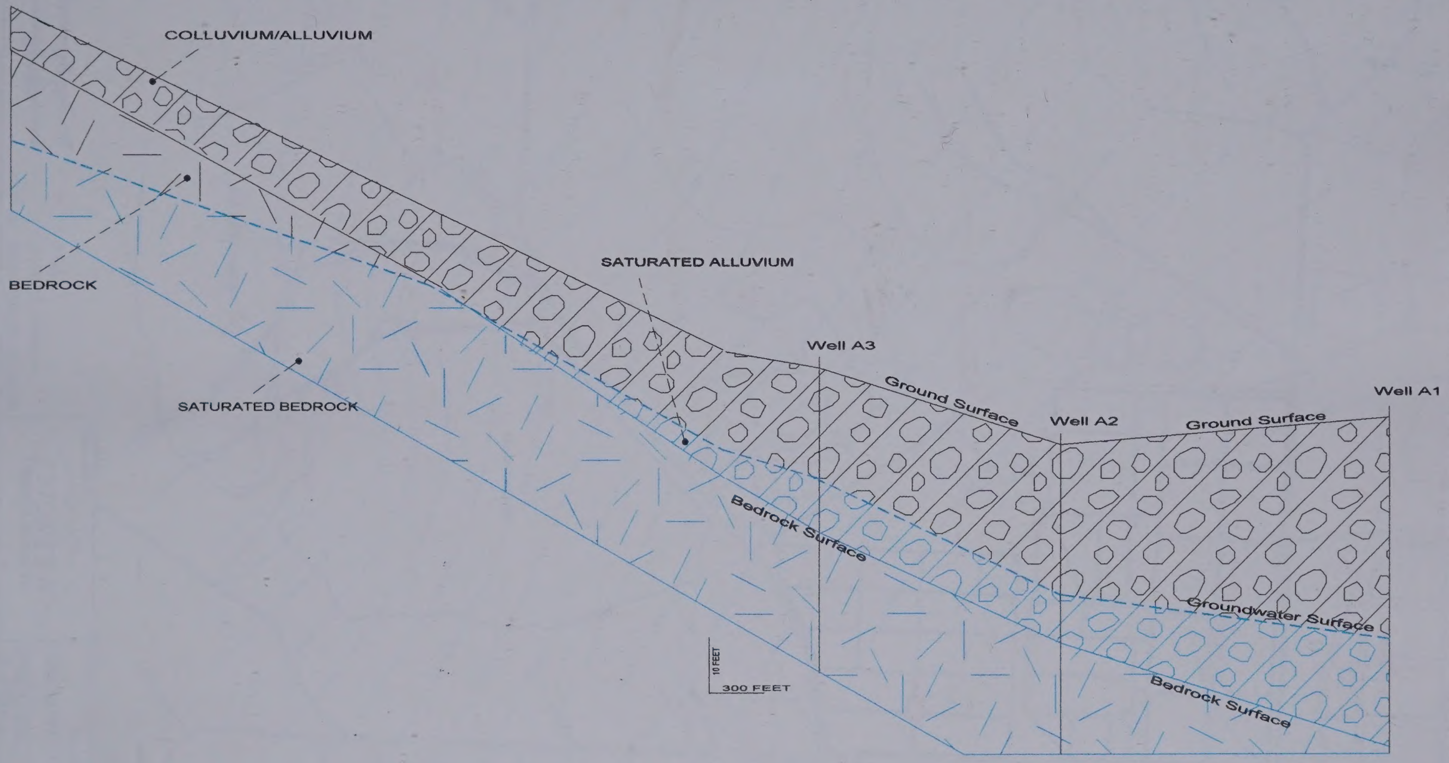
COLLUVIUM/ALLUVIUM
BEDROCK
SATURATED ALLUVIUM
SATURATED BEDROCK
Well A3
Well A2
Well A1
Ground Surface
Ground Surface
Bedrock Surface
Groundwater Surface
Bedrock Surface
10 FEET
300 FEET

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FIGURE 2-4
SITE GEOLOGIC CROSS-SECTION

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DATE: 04/07/95

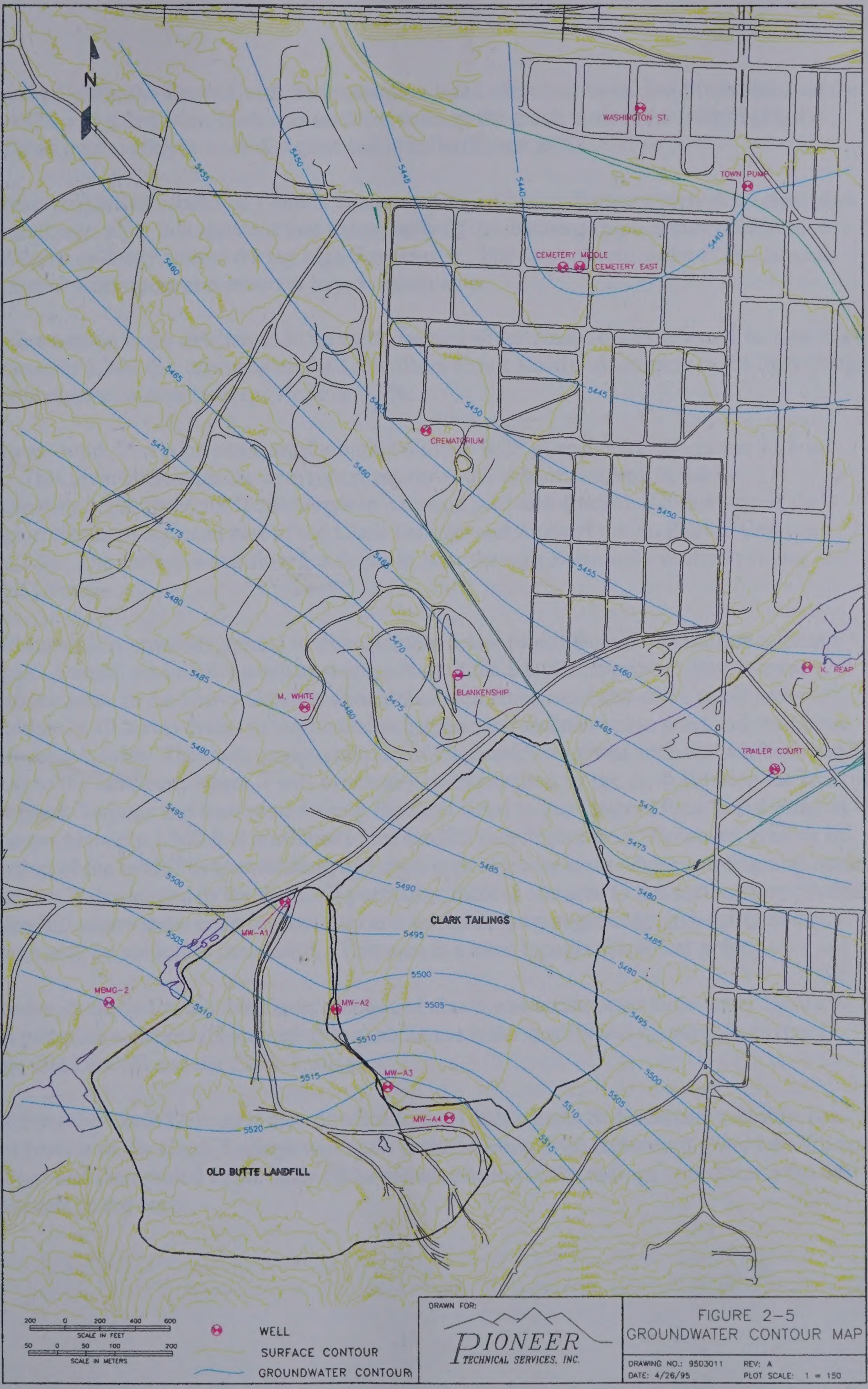
N
WASHINGTON ST.
TOWN PUMP
CEMETERY MIDDLE
CEMETERY EAST
CREMATORIUM
BLANKENSHIP
M. WHITE
K. REAP
TRAILER COURT
MW-A1
MBMG-2
MW-A2
MW-A3
MW-A4
CLARK TAILINGS
OLD BUTTE LANDFILL
5440
5445
5450
5455
5460
5465
5470
5475
5480
5485
5490
5495
5500
5505
5510
5515
5520
200 0 200 400 600
SCALE IN FEET
50 0 50 100 200
SCALE IN METERS
WELL
SURFACE CONTOUR
GROUNDWATER CONTOUR
DRAWN FOR:
PIONEER TECHNICAL SERVICES, INC.
DRAWING NO.: 9503011
REV: A
DATE: 4/26/95
PLOT SCALE: 1 = 150

FIGURE 2–5
GROUNDWATER CONTOUR MAP

In the early 1980's, the Grove Gulch Sedimentation Pond was constructed west (upstream) of the Old Landfill and a diversion ditch was installed to route the gulch around the landfill (Figure 2-1). These improvements were designed and installed by the SCS.

The Grove Gulch Sedimentation Pond is equipped with a 12-inch diameter corregated steel pipe (CSP) discharge pipe; it is apparent that the capacity of the discharge pipe is exceeded at times and the dam's spillway is used during high flow events. The downstream slope of the dam has been covered with riprap and concrete to prevent erosion.

The sedimentation basin discharges to an earth channel which routes the flow to a diversion inlet approximately 1,200 feet downstream (at Little Basin Creek Road). According to the SCS design plans, this channel is at an average slope of 0.3%.

The Grove Gulch Diversion consists of a buried 42-inch RCP at a slope ranging from 1.24 to 2.20%. This diversion routes the drainage along the south side of Beeftrail Road for approximately 2,500 feet until it discharges to a plunge pool and ditch on the east side of the Burlington Northern Railroad east of the Clark Tailings and south of the St. Patrick Cemetery (Figure 2-1). The surface water flow continues to flow through Butte and eventually drains to Blacktail Creek.

The Old Landfill is currently graded to direct surface water runoff from the landfill to adjacent drainages. A small area on the southwestern portion of the landfill (approximately 8 acres) drains to the west, to the Grove Gulch sedimentation pond discussed above. A small area (approximately 12 acres) drains to the diversion between the sedimentation pond and the Grove Gulch diversion inlet. The northwestern portion of the landfill is graded such that surface runoff will flow to the northeast, where it will eventually be intercepted by the ditch between the landfill and the Clark Tailings and then routed along Beeftrail Road to the Timber Butte Sedimentation Basin, approximately 1,500 feet northeast of the landfill (see Figure 2-1). However, grading in this portion of the landfill is inconsistent, and there appears to be areas where ponding may occur before water is discharged to the ditch. In particular, there is one area in the northeastern portion of the landfill where there are a few willows and wetlands grasses growing, indicating that this small area may be subject to inundation. This area is a local topographical low point.

The Timber Butte Sedimentation Basin mentioned above was constructed in the early 1980's to address potential concerns (discussed above) about the water quality and quantity from runoff from the Old Landfill and the Clark Tailings.

Runoff from the Clark Tailings is also directed to the Timber Butte Sedimentation Basin. The western portion of the Clark Tailings will drain to the existing ditch between the Old Landfill and the tailings and then routed to the basin. The eastern portion of the tailings will drain to the east and northeast to the basin.

The Timber Butte Sedimentation Basin is dewatered by a 36-inch diameter RCP perforated riser. The dewatering structure is perforated below the ground surface to allow for subsurface dewatering of the basin. This drop inlet connects to the Grove Gulch diversion described above. This diversion routes the storm water runoff under the Burlington Northern Railroad grade (Figure 2-1), where it discharges to a plunge pool. From the plunge pool, a ditch continues east and eventually the drainage discharges to Blacktail Creek on the east side of Lexington Avenue.

2.3.4.2 Surface Water Quality

According to environmental documentation prepared by SCS during the planning and design of the Grove Gulch Sedimentation Pond and diversion, water quality in Grove Gulch upgradient of the site is excellent. Water quality changed very little after if flowed through the wooden culvert under the Old Landfill and past the Clark Tailings.

Surface water quality samples were collected above and below the Old Landfill on four occasions in 1991 and 1992 by MBMG personnel. These samples were collected well after the installation of the Grove Gulch Sedimentation Pond and the Timber Butte Sedimentation Basin. One sample location is described as Grove Gulch, above the landfill and the other is described as Grove Gulch, below the landfill, near Montana Street. This downgradient sampling point would represent the potential contribution by the landfill to the surface water. It also represents the potential contribution by a substantial area east of the Old Landfill and Clark Tailings, including the railroad right-of-way, a livestock facility, and a trucking facility. The analytical data for these samples are included in Appendix A and are discussed in Section 5.2.

2.4 CURRENT SITE SETTING

2.4.1 Location and Topography

The Old Landfill/Clark Tailings site is located in portions of Sections 25, 26, 35, and 36 of Township 3 North, Range 8 West in Butte-Silver Bow County, Montana (Figure 1-1). The 130 acre site is located approximately one mile southwest of the city of Butte. The site sits on a predominately south facing slope, which averages 4%.

2.4.2 Vegetation and Wildlife

Vegetation at the Old Landfill/Clark Tailings site is inconsistent. Portions of the site, where adequate soil cover has been installed and graded properly, have a healthy stand of bunch grasses typical of the semi-arid upland ranges of the region. However, portions of the site have little or no vegetative cover. These areas typically have not received adequate soil cover (capable of supporting a vegetative growth), are graded too steeply, have not been seeded, or have been subjected to erosion.

In the Butte area, the bluebunch wheatgrass (*Agropyron spicatum*)/bluegrass (*Poa* spp.)/rubber rabbitbrush (*Chrysothamnus nauseousus*) plant community is predominant (JMM, 1993). This plant community probably existed at the site before waste disposal activities began.

No listed threatened or endangered species are present at the site. The vicinity is mapped as potential habitat for the Prebles shrew, which is currently at U.S. Fish and Wildlife Service (USFWS) C2 status (Montana Natural Heritage Program, 1995). C2 is a notice of review status, meaning that proposing to list the species as a threatened or endangered species may be appropriate, but adequate biological information is not available. The species is ranked G4 (apparently secure) within it's range, and S3 (either rare and local or found locally in a restricted range) in Montana. The shrew is not known to inhabit the area of the site; therefore, any actions taken at the site will not impact known shrew habitat. No aquatic wildlife is present in Grove Gulch, an intermittent stream.

2.4.3 Historic or Archaeologically Significant Features

No historic or archaeologically significant features are known to exist on the site. The Clark Tailings have been reclaimed previously (in the mid-1980's), and as such have already been displaced from their historical setting.

2.4.4 Land Use

2.4.4.1 Current Land Use

Currently, the Old Landfill site is predominately unused. As discussed in Section 2.1.1, the landfill is in the process of being closed, approximately 55% of the landfill cap has been installed as of March 1, 1995. The entrance to the landfill is posted as closed, with directions to the new landfill west of Butte. A small portion of the landfill is used for the disposal of demolition debris, as approved by MDHES. The public does not have access to this disposal area.

The Clark Tailings are not currently in use. Access to the Clark Tailings is controlled via a perimeter fence. The majority of the Clark Tailings have been reclaimed in the mid-1980's; the land has not been used since.

2.4.4.2 Future Land Use

Future land uses must be considered when developing and evaluating corrective measures. The corrective measures selected must support the intended future land use. At the Old Landfill/Clark Tailings site, future land uses are outlined in the BSB Land Use Master Plan. The future land use is designated as open space/recreational. Current zoning precludes residential development on the site. The recreational uses may specifically include the development of athletic fields, park settings, golfing, and other outdoor recreational facilities. Restrictive covenants will be placed upon the site in accordance with ARM 16.14.530 and private party agreements will also limit future land uses.

2.4.5 Groundwater Use

There are no current groundwater extraction wells on the site itself. Most wells downgradient of the site (shown on Figure 2-5) are used for irrigation (including the wells owned by Reap, Blankenship, and the cemetery wells). There are no known drinking water supply wells downgradient of the site.

2.4.6 Surface Water Use

There are no known surface water uses of Grove Gulch downgradient of the site. No surface water rights are registered with the Montana Department of Natural Resources and Conservation (DNRC) for Grove Gulch downgradient of the landfill.

3.0 WASTE CHARACTERISTICS

3.1 OLD BUTTE-SILVER BOW LANDFILL

The Old Landfill served as a municipal solid waste repository from approximately 1968 until it closed in 1994. As such, typical municipal solid wastes (or Group II wastes per MDHES regulations at ARM 16.14.503) were disposed at the site. The specific quantity of wastes on-site are not known. However, based on an average depth of waste of 15 feet over an estimated 60 acres that received wastes, and a 4:1 waste:cover soil ratio, it can be estimated that approximately 1.2 million cubic yards of waste have been disposed at the site. At an estimated average in-place waste density of 1,000 lb/cubic yard (SWANA, 1991), approximately 600,000 tons of refuse have been disposed at the site. This would equal an average generation rate of 4 pounds per capita per day during the life of the landfill. This is consistent with the typical solid waste generation values reported by SWANA (1991), and slightly higher than those reported by McBean, et al (1995).

Wastes landfilled at the site may have potentially led to elevated concentrations of constituents of concern in localized groundwater, as determined by the groundwater monitoring conducted to date. Groundwater quality data available to date are summarized in Table 3-1. All ARM 16.14.706 Table 2 constituents were analyzed during the sampling event in August of 1994. Since then, only the analytical procedures which detected analytes (above the instrument detection limit [IDL]) have been performed. Only those constituents which were detected above the IDL in the groundwater samples are included in Table 3-1. Sample locations are presented in Figure 2-3.

The following volatile organic contaminants have been detected in the landfill monitoring wells:

- acetone
- chloroethane
- 1,4-dichlorobenzene

	MBMG-2						BSB-A2						
	4/93	2/94	8/94	1/95	2/95	3/95	4/93	2/94	8/94	1/95	2/95	3/95	MCL/MCLG
DISSOLVED METALS (mg/L)													
Antimony		<0.002	NA	0.004 F	0.009 F	<0.003		<0.002	0.005	0.003 F	<0.003	0.005 F	0.006 / 0.006
Arsenic	<0.005	0.002	NA	0.002	0.003	0.047	<0.005	0.004	0.008	0.012	0.011	0.012	0.05
Barium	0.2	0.133	NA	0.142	0.136	0.176	0.2	0.040	0.058	0.075	0.085	0.080	2 / 2
Berrylium		<0.003	NA	<0.001	<0.001	0.0001 F		<0.003	<0.001	<0.001	0.002	0.0001 F	0.004 / 0.004
Cadmium	<0.001	0.0003	NA	<0.0001	<0.0001	0.0001	<0.001	0.0231	0.01	0.0023	0.0013	0.0013	0.005 / 0.005
Chromium	<0.01	<0.007	NA	0.009	<0.009	<0.009	<0.01	0.007	<0.007	<0.008	<0.009	<0.009	0.1 / 0.1
Cobalt		<0.009	NA	<0.010	<0.010	<0.010		0.032	0.023	0.019	0.012	<0.010	
Copper		<0.007	NA	<0.002	<0.002	0.002 F		<0.007	<0.006	<0.002	<0.002	0.002 F	NA / 1,300
Iron	1.89	<0.013	NA	0.015	0.055	84.6	4.51	0.729	4.12	8.81	10.4	8.21	
Lead	<0.01	<0.001	NA	<0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	(0.015) / 0
Mercury	<0.001	<0.0002	NA	<0.0001	<0.0001	0.0002	<0.001	<0.0002	0.0001	<0.0001	<0.0001	<0.0001	0.002 / 0.002
Nickel		<0.015	NA	<0.02	<0.01	<0.01		0.090	<0.014	0.02	<0.01	0.03	0.1 / 0.1
Selenium	<0.005	0.001	NA	<0.001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	0.05 / 0.05
Silver	<0.005	<0.004	NA	<0.002	<0.0004	<0.0004	<0.005	<0.004	<0.004	0.004	<0.0004	<0.0004	
Thallium		<0.001	NA	0.006	0.006 F	0.008		<0.001	0.005	0.006	0.006 F	0.010	0.002 / 0.0005
Vanadium		0.012	NA	0.010 F	0.006	<0.004		<0.009	<0.009	<0.004 F	<0.004	<0.004	
Zinc		<0.007	NA	<0.01	0.03	0.04		18.9	7.65	2.09	1.39	1.49	
INORGANICS (mg/L)													
Cyanide	<0.005	<0.005	NA	NR	NR	NR	<0.005	<0.005	<0.005	NR	NR	NR	0.2 / 0.2
Conductivity (umhos/cm)	714	742	NA	676	700	1150	1330	1980	1650	1650	1710	1620	
Chloride	52	64	NA	57	57	37	109	128	140	126	117	120	
Sulfate	124	134	NA	136	123	39	116	664	218	198	288	181	
Sulfide	NR	NR	NA	NR	NR	NR	NR	NR	<1.5	NR	NR	NR	
COD	<1	<20	NA	25	48	169	<1	243	443	21	109	115	
Nitrate\Nitrite - N	5.9	5.5	NA	4.88	3.99	39	<0.05	<0.05	<0.05	<0.05	0.09	0.09	10 / 10
EPA METHOD 8260 (ug/L) **(METHOD 8240 ON 4/93)**													
Acetone		<50	NR	<50	<50	<50		<50	<50 F	<50	<50	<50	
Benzene		<1.0	NR	<1.0	<1.0	3.6		<1.0 (0.89J)	1.6	1.5	1.6	1.4	5 / 0
Carbon Disulfide		<1.0 (0.75J)	NR	1.2 F	<1.0 (0.99J)	<1.0		1.5	<1.0 F	0.12J F	<1.0 (0.12J)	<1.0	
Chloroform		<1.0 (0.75J)	NR	<1.0 (0.84J)	<1.0 (0.98J)	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	
Chloroethane		<1.0	NR	<1.0	<1.0	1.1		<1.0	<1.0	<1.0	<1.0	<1.0	
Chloromethane		<1.0 F	NR	<1.0	<1.0	<1.0		2 F	<1.0	<1.0	<1.0	<1.0	
1,2-Dichlorobenzene		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0 (0.74J)	600 / 600
1,4-Dichlorobenzene		<1.0	NR	<1.0	<1.0	4.8		1.7	3.3	4.2	4.8	4.7	75 / 75
Dichlorodifluoromethane		<1.0	NR	<1.0	<1.0	1.6	27 D	16	18	20 D	27 D1	23 D	
Dichlorofluoromethane		<1.0	NR	<1.0	<1.0	<1.0		15	<1.0	<1.0	<1.0	<1.0	
1,1-Dichloroethane		<1.0	NR	<1.0	<1.0	1.1	9.8	6.6	12	13	14	14	
1,2-Dichloroethane		<1.0 F	NR	<1.0	<1.0	<1.0	1.4	4.9 F	2	2.0	1.8	<1.0	5 / 0
1,1-Dichloroethene		<1.0	NR	<1.0	<1.0	<1.0		<1.0 (0.33J)	<1.0 (0.51J)	<1.0 (0.50J)	<1.0 (0.58J)	<1.0 (0.53J)	7 / 7
cis-1,2-Dichloroethene		<1.0	NR	<1.0	<1.0	57 D		91	180 D	160 D	196 D2	156 D	70 / 70
trans-1,2-Dichloroethene		<1.0	NR	<1.0	<1.0	<1.0 (0.25J)		<1.0 (0.94J)	1.3	1.5	1.7	1.5	100 / 100
1,2-Dichloropropane		<1.0	NR	<1.0	<1.0	<1.0		1.4	2.2	2.3	2.2	2.3	5 / 0
Ethyl Benzene		<1.0	NR	<1.0	<1.0	<1.0 (0.87J)		<1.0	<1.0	<1.0	<1.0	<1.0	700 / 700
Methylene Chloride		<1.0	NR	<1.0	<1.0	<1.0		1.8	1.8	1.4	1.6	2.0	5 / 5
Tetrachloroethene		<1.0	NR	<1.0	<1.0	<1.0	8.0	6.9	6.4	6.1	6.9	7.4	5 / 0
1,1,1-Trichloroethane		<1.0	NR	<1.0	<1.0	<1.0		8.8	<1.0	<1.0	<1.0	<1.0	200 / 200
Toluene		<1.0	NR	<1.0	<1.0	<1.0 (0.16J)		<1.0	<1.0 F	<1.0	<1.0	<1.0	1,000 / 1,000
Trichloroethene		<1.0	NR	<1.0	<1.0	1.1	20	14	14	14	15	16	5 / 0
Trichlorofluoromethane		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	
Vinyl Chloride		<1.0	NR	<1.0	<1.0	1.2		<1.0	3.9	3.8	4.1	3.6	2 / 0
m+p Xylenes		<1.0	NR	<1.0	<1.0	<1.0 (0.74J)		<1.0	<1.0	<1.0	<1.0	<1.0	10,000 / 10,000
o-Xylene		<1.0	NR	<1.0	<1.0	<1.0 (0.14J)		<1.0	<1.0	<1.0	<1.0	<1.0	
EPA METHOD 8270 (ug/L)													
1,4-Dichlorobenzene	NA	NA	NA	<10	<11	<10 (3.0J)	NA	NA	<10 (2.8J)	<10 (2.3J)	<10 (3.1J)	<10 (3.0J)	75 / 75
Diethylphthalate	NA	NA	NA	<10	<11	<10	NA	NA	<10 (2.4J)	<10 (1.3J)	<10 (1.7J)	<10 (3.8J)	
Di-n-Butylphthalate	NA	NA	NA	<10	<11	<10	NA	NA	<10 (0.70JB)	<10	<10	<10	
bis(2-ethylhexyl) Phthalate	NA	NA	NA	<10	<11	<10	NA	NA	<10 (1.4JB)	<10 (0.79J)	<10	<10	6 / 6

NR = Not Requested
NA = Not Sampled
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
B = Analyte detected in associated reagent blank
D = Value derived from a 10X dilution
F = Analyte detected in associated field blank
D1 = Value derived from a 5.7X dilution
D2 = Value derived from a 50X dilution

2.4.5 Groundwater Use

There are no current groundwater extraction wells on the site itself. Most wells downgradient of the site (shown on Figure 2-5) are used for irrigation (including the wells owned by Reap, Blankenship, and the cemetery wells). There are no known drinking water supply wells downgradient of the site.

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3.0 WASTE CHARACTERISTICS

3.1 OLD BUTTE-SILVER BOW LANDFILL

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- acetone
- chloroethane
- 1,4-dichlorobenzene

TABLE 3-1: OLD BUTTE-SILVER BOW LANDFILL, GROUNDWATER MONITORING RESULTS

	MBMG-2						BSB-A1						BSB-A4						BSB-A3						BSB-A2						
	4 / 93	2 / 94	8 / 94	1 / 95	2 / 95	3 / 96	4 / 93	2 / 94	8 / 94	1 / 95	2 / 95	3 / 96	4 / 93	2 / 94	8 / 94	1 / 95	2 / 95	3 / 95	4 / 93	2 / 94	8 / 94	1 / 95	2 / 95	3 / 96	4 / 93	2 / 94	8 / 94	1 / 95	2 / 95	3 / 95	MCL/MCLG
DISSOLVED METALS (mg/L)																															
Antimony		<0.002	NA	0.004 F	0.009 F	0.004 F		<0.002	<0.002	0.006 F	0.007 F	<0.003		<0.002	<0.002	0.005 F	0.006 F	0.003 F		<0.002	<0.002	0.003 F	0.005 F	<0.003		<0.002	0.005	0.003 F	<0.003	0.005 F	0.006 / 0.006
Arsenic	<0.005	0.002	NA	0.002	0.003	<0.001	0.014	0.004	<0.002	0.002	0.003	<0.001	<0.005	0.004	0.002	0.003	0.004	0.002	0.008	0.015	0.025	0.044	0.042	0.047	<0.005	0.004	0.008	0.012	0.011	0.012	0.05
Barium	0.2	0.133	NA	0.142	0.136	0.132	0.2	0.122	0.122	0.081	0.081	0.072	0.1	0.043	0.033	0.031	0.044	0.031	0.5	0.077	0.117	0.171	0.192	0.176	0.2	0.040	0.058	0.075	0.085	0.080	2 / 2
Berrylium		<0.003	NA	<0.001	<0.001	0.002 F		<0.003	<0.001	<0.001	<0.001	0.0002 F		<0.003	0.001	<0.001	<0.001	0.0001 F		<0.003	<0.001	<0.001	<0.001	0.0001 F		<0.003	<0.001	<0.001	0.002	0.0001 F	0.004 / 0.004
Cadmium	<0.001	0.0003	NA	<0.0001	<0.0001	0.0004	<0.001	0.0007	<0.004	0.0003	0.0001	0.0001	0.002	<0.0001	<0.004	<0.0001	0.0001	0.0001	0.003	0.0002	<0.004	<0.0001	0.0001	0.0001	<0.001	0.0231	0.01	0.0023	0.0013	0.0013	0.005 / 0.005
Chromium	<0.01	<0.007	NA	0.009	<0.009	<0.009	<0.01	<0.007	<0.007	<0.008	<0.009	<0.009	<0.01	<0.007	<0.007	<0.008	<0.009	<0.009	<0.01	<0.007	<0.007	<0.008	<0.009	<0.009	<0.01	0.007	<0.007	<0.008	<0.009	<0.009	0.1 / 0.1
Cobalt		<0.009	NA	<0.010	<0.010	<0.010		<0.009	<0.008	<0.010	<0.010	<0.010		<0.009	<0.008	<0.010	<0.010	<0.010		0.022	<0.008	<0.010	<0.010	<0.010		0.032	0.023	0.019	0.012	<0.010	
Copper		<0.007	NA	<0.002	<0.002	0.008 F		<0.007	<0.006	<0.002	<0.002	0.005 F		<0.007	<0.006	<0.002	<0.002	0.009 F		<0.007	<0.006	<0.002	<0.002	0.002 F		<0.007	<0.006	<0.002	<0.002	0.002 F	NA / 1,300
Iron	1.89	<0.013	NA	0.015	0.055	0.222	12.5	0.022	<0.01	0.026	0.080	<0.013	0.04	<0.013	<0.01	<0.009	<0.013	<0.013	29.5	50.9	68.9	92.3	82.0	84.6	4.51	0.729	4.12	8.81	10.4	8.21	
Lead	<0.01	<0.001	NA	<0.001	<0.001	<0.001	0.05	0.002	<0.001	<0.001	<0.001	0.002	<0.01	<0.001	0.001	<0.001	0.002	<0.001	<0.01	<0.001	<0.001	0.001	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	(0.015) / 0
Mercury	<0.001	<0.0002	NA	<0.0001	<0.0001	0.0002	<0.001	<0.0002	0.0003	<0.0001	<0.0001	<0.0001	<0.001	0.0002	0.0003	<0.0001	<0.0001	0.0002	<0.001	<0.0002	0.0003	<0.0001	<0.0001	0.0002	<0.001	<0.0002	0.0001	<0.0001	<0.0001	<0.0001	0.002 / 0.002
Nickel		<0.015	NA	<0.02	<0.01	<0.01		<0.015	<0.014	<0.02	<0.01	<0.01		<0.015	<0.014	<0.02	<0.01	<0.01		<0.015	<0.014	<0.02	<0.01	<0.01		0.090	<0.014	0.02	<0.01	0.03	0.1 / 0.1
Selenium	<0.005	0.001	NA	<0.001	<0.001	<0.001	<0.005	<0.001	0.002	<0.001	<0.001	<0.001	<0.005	0.003	0.003	0.001	<0.001	<0.001	<0.005	<0.001	0.002	<0.001	<0.001	<0.001	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	0.05 / 0.05
Silver	<0.005	<0.004	NA	<0.002	<0.0004	<0.0004	<0.005	<0.004	<0.004	<0.002	<0.0004	<0.0004	<0.005	<0.004	<0.004	<0.002	<0.0004	<0.0004	<0.005	<0.004	<0.004	0.004	<0.0004	<0.0004	<0.005	<0.004	<0.004	0.004	<0.0004	<0.0004	
Thallium		<0.001	NA	0.006	0.006 F	0.005		<0.001	0.005	0.007	0.005 F	0.005		<0.001	0.006	0.005	0.005 F	0.003		0.002	0.006	0.007	0.021 F	0.008		<0.001	0.005	0.006	0.006 F	0.010	0.002 / 0.0005
Vanadium		0.012	NA	0.010 F	0.006	0.013		<0.009	<0.009	0.004 F	<0.004	<0.004		<0.009	<0.009	0.009 F	0.006	0.007		<0.009	<0.009	0.007 F	<0.004	<0.004		<0.009	<0.009	<0.004 F	<0.004	<0.004	
Zinc		<0.007	NA	<0.01	0.03	0.02		0.017	<0.016	<0.01	0.02	0.01		<0.007	<0.016	<0.01	0.03	<0.01		0.918	0.155	0.03	0.09	0.04		18.9	7.65	2.09	1.39	1.49	
INORGANICS (mg/L)																															
Cyanide	<0.005	<0.005	NA	NR	NR	NR	<0.005	<0.005	<0.005	NR	NR	NR	<0.005	<0.005	<0.005	NR	NR	NR	<0.005	<0.005	<0.005	NR	NR	NR	<0.005	<0.005	<0.005	NR	NR	NR	0.2 / 0.2
Conductivity (umhos/cm)	714	742	NA	676	700	701	581	591	654	450	418	426	1450	758	627	573	586	580	1190	1100	1170	1190	1010	1150	1330	1980	1650	1650	1710	1620	
Chloride	52	64	NA	57	57	61	35	20	17	15	14	15	276	21	9	5	5	6	24	55	49	42	40	37	109	128	140	126	117	120	
Sulfate	124	134	NA	136	123	136	112	148	176	100	85	84	178	219	172	156	148	162	68	130	77	49	51	39	116	664	218	198	288	181	
Sulfide	NR	NR	NA	NR	NR	NR	NR	NR	<1.5	NR	NR	NR	NR	NR	<1.5	NR	NR	NR	NR	NR	<1.5	NR	NR	NR	NR	NR	<1.5	NR	NR	NR	
COD	<1	<20	NA	25	48	80	<1	33	44	47	28	131	<1	<20	22	3	16	33	<1	79	94	60	92	169	<1	243	443	21	109	115	
Nitrate\Nitrite - N	5.9	5.5	NA	4.88	3.99	5.17	0.29	<0.05	0.61	0.46	0.68	0.64	1.98	1.1	1.27	1.10	0.91	0.68	<0.05	<0.05	<0.05	<0.05	0.05	39	<0.05	<0.05	<0.05	<0.05	0.09	0.09	10 / 10
EPA METHOD 8260 (ug/L) (METHOD 8240 ON 4/93)																															
Acetone		<50	NR	<50	<50	<50(40J)		<50	73 F	<50	<50	<50		<50	<50 F	<50	<50	<50		<50	127 F	<50	<50	<50		<50	<50 F	<50	<50	<50	
Benzene		<1.0	NR	<1.0	<1.0	<1.0		<1.0 (0.19J)	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	1.1	2.1	1.8	3.4	3.7	3.6		<1.0 (0.89J)	1.6	1.5	1.6	1.4	5 / 0
Carbon Disulfide		<1.0 (0.75J)	NR	1.2 F	<1.0 (0.99J)	<1.0		<1.0	0.85J F	0.61J F	<1.0	<1.0		3.9	1.2 F	2.9 F	14	<1.0		1.4	<1.0 F	<1.0 F	<1.0 (0.12J)	<1.0		1.5	<1.0 F	0.12J F	<1.0 (0.12J)	<1.0	
Chloroform		<1.0 (0.75J)	NR	<1.0 (0.84J)	<1.0 (0.98J)	<1.0 (0.81J)		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	
Chloroethane		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0 (0.86J)	1.3	1.4	1.1		<1.0	<1.0	<1.0	<1.0	<1.0	
Chloromethane		<1.0 F	NR	<1.0	<1.0	<1.0		0.83J F	<1.0	<1.0	<1.0	<1.0		0.68J F	<1.0	<1.0	<1.0	<1.0		<1.0 F	<1.0	<1.0	<1.0	<1.0		2 F	<1.0	<1.0	<1.0	<1.0	
1,2-Dichlorobenzene		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0 (0.74J)	600 / 600
1,4-Dichlorobenzene		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		1.9	3.7	5.1	5.1	4.8		1.7	3.3	4.2	4.8	4.7	75 / 75
Dichlorodifluoromethane		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0 (0.40J)	<1.0 (0.15J)	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	2.0	<1.0	1.1	1.5	1.6	1.8	27 D	16	18	20 D	27 D1	23 D	
Dichlorofluoromethane		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0 (0.88J)	<1.0	<1.0	<1.0	<1.0		15	<1.0	<1.0	<1.0	<1.0	
1,1-Dichloroethane		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	3.8	1.1	1.2	<1.0 (0.99J)	1.1	1.1	9.8	6.6	12	13	14	14	
1,2-Dichloroethane		<1.0 F	NR	<1.0	<1.0	<1.0		1.2 F	<1.0	<1.0	<1.0	<1.0		2.4 F	<1.0	<1.0	<1.0	<1.0		3.3 F	<1.0	<1.0	<1.0	<1.0	1.4	4.9 F	2	2.0	1.8	<1.0	5 / 0
1,1-Dichloroethene		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0 (0.33J)	<1.0 (0.51J)	<1.0 (0.50J)	<1.0 (0.58J)	<1.0 (0.53J)	7 / 7
cis-1,2-Dichloroethene		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0 (0.74J)	<1.0 (0.39J)	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1(0.13J)		36	38 D	53 D	60 D	57 D		91	180 D	160 D	196 D2	156 D	70 / 70
trans-1,2-Dichloroethene		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0 (0.26J)	<1.0 (0.30J)	<1.0 (0.25J)		<1.0 (0.94J)	1.3	1.5	1.7	1.5	100 / 100
1,2-Dichloropropane		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		1.4	2.2	2.3	2.2	2.3	5 / 0
Ethyl Benzene		<1.0	NR	<1.0	<1.0	<1.0	<1.0J	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		5.8	2.2	1.6	<1.0 (0.79J)	<1.0 (0.87J)		<1.0	<1.0	<1.0	<1.0	<1.0	700 / 700
Methylene Chloride		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		1.8	1.8	1.4	1.6	2.0	5 / 5
Tetrachloroethene		<1.0	NR	<1.0	<1.0	<1.0		1.8	3.3	1.6	<1.0 (0.59J)	<1.0 (0.75J)		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0 (0.26J)	<1.0 (0.55J)	<1.0	<1.0	<1.0	8.0	6.9	6.4	6.1	6.9	7.4	5 / 0
1,1,1-Trichloroethane		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		3.7	<1.0	<1.0	<1.0	<1.0		8.8	<1.0	<1.0	<1.0	<1.0	200 / 200
Toluene		<1.0	NR	<1.0	<1.0	<1.0	<1.0J	<1.0	0.54J F	<1.0	<1.0 (0.11J)	<1.0		<1.0	0.22J F	<1.0	<1.0 (0.14J)	<1.0		<1.0	<1.0 F	<1.0	<1.0 (0.18J)	<1.0 (0.16J)		<1.0	<1.0 F	<1.0	<1.0	<1.0	1,000 / 1,000
Trichloroethene		<1.0	NR	<1.0	<1.0	<1.0		<1.0 (0.40J)	<1.0 (0.72J)	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	1.1	1.4	1.8	1.0	1.0	1.1	20	14	14	14	15	16	5 / 0
Trichlorofluoromethane		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0 (0.18J)	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	
Vinyl Chloride		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0J	<1.0	<1.0	1.3	1.2	1.2		<1.0	3.9	3.8	4.1	3.6	2 / 0
m+p Xylenes		<1.0	NR	<1.0	<1.0	<1.0	2.5	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		1	<1.0 (0.62J)	1.4	1.1	<1.0 (0.74J)		<1.0	<1.0	<1.0	<1.0	<1.0	10,000 / 10,000
o-Xylene		<1.0	NR	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0 (0.26J)	<1.0 (0.14J)	<1.0 (0.14J)		<1.0	<1.0	<1.0	<1.0	<1.0	
EPA METHOD 8270 (ug/L)																															
1,4-Dichlorobenzene	NA	NA	NA	<10	<11	<10	NA	NA	<10	<10	<11	<10	NA	NA	NA	<10	<11	<10	NA	NA	<10 (2.2J)	<10 (3.0J)	<11 (2.3J)	<10 (3.0J)	NA	NA	<10 (2.8J)	<10 (2.3J)	<10 (3.1J)	<10 (3.0J)	75 / 75
Diethylphthalate	NA	NA	NA	<10	<11	<10	NA	NA	<10	<10	<11	<10	NA	NA	NA	<10	<11	<10	NA	NA	<10 (1.4J)	<10 (2.1J)	<11	<10	NA	NA	<10 (2.4J)	<10 (1.3J)	<10 (1.7J)	<10 (3.8J)	
Di-n-Butylphthalate	NA	NA	NA	<10	<11	<10	NA	NA	<10	<10	<11	<10	NA	NA	NA	<10	<11	<10	NA	NA	<10	<10	<11	<10	NA	NA	<10 (0.70JB)	<10	<10	<10	
bis(2-ethylhexyl) Phthalate	NA	NA	NA	<10	<11	<10	NA	NA	<10	<10 (0.91J)	<11	<10	NA	NA	NA	<10	<11 (4.2J)	<10	NA	NA	<10	<10	<11	<10	NA	NA	<10 (1.4JB)	<10 (0.79J)	<10	<10	6 / 6

NR = Not Requested
NA = Not Sampled
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
B = Analyte detected in associated reagent blank
D = Value derived from a 10X dilution
F = Analyte detected in associated field blank
D1 = Value derived from a 5.7X dilution
D2 = Value derived from a 50X dilution

- 1,1-dichloroethane
- cis-1,2-dichloroethene
- trichloroethene
- trans-1,2-dichloroethene
- ethyl benzene
- m+p xylenes
- benzene
- chloromethane
- dichlorodifluouromethane
- 1,2-dichloroethane
- vinyl chloride
- tetrachloroethene
- 1,2-dichloropropane
- 1,1,1-trichloroethane

Also, some inorganic constituents were detected at concentrations greater than groundwater protection standards. An assessment of the detected groundwater contaminants is presented in Section 5.1.

3.2 CLARK TAILINGS

The source of the Clark Tailings was the Timber Butte Mill, which began operation in 1914 and was dismantled in 1948. During it's years of operation, the mill served primarily as a zinc and copper concentrator. Ore from the Elm Orlu Mine, north of Butte and east of Walkerville, was processed at the mill. According to a 1915 paper on the operation of the mill (Simons, 1915), the tailings from the mill contained the following fractions (in parts per million):

- copper: 700
- silver: 19
- gold: 0.053
- iron: 1400
- zinc: 12,000
- lead: 500
- insolubles (percent): 95.12

The Clark Tailings were reclaimed in the mid-1980's by the Anaconda Minerals Company. While much of area was regraded, covered, and revegetated, there are many areas where tailings are currently present at the surface.

Per a 1989 EPA Administrative Order on Consent, the constituents of concern (CoC) for the Timber Butte Mill Site (the source of the Clark Tailings) were: arsenic, cadmium, lead, zinc, and copper. This Order required a Removal Action at the Mill Site (which was conducted in 1989). The Order mentions reclamation of a drainage immediately east of the Clark Tailings, but did not address the Clark Tailings directly. For purposes of this CMA the primary CoC for the Clark

Tailings Site are consistent with the CoC for the Timber Butte Site (arsenic, cadmium, copper, lead and zinc).

Four samples collected from the upper two feet of the Clark Tailings have been analyzed for metals content (two samples collected in 1982 and two samples collected in 1987). The following CoC concentration ranges were reported (McCulley, Frick, and Gilman, 1993):

- arsenic: 166 to 934 mg/kg
- copper: 314 to 761 mg/kg
- lead: 335 to 1440 mg/kg
- zinc: 1210 to 4640 mg/kg

4.0 SUMMARY OF PRELIMINARY REMEDIATION GOALS

In this section, the preliminary remediation goals identified for the site are discussed. ARM solid waste regulations will dictate most standards for the site. For instance, landfill closure and groundwater protection standards are addressed by the ARM. These goals are summarized in the following sections.

4.1 LANDFILL CLOSURE

For areas that received waste after October 9, 1991, EPA regulations (40 CFR 258.60 and ARM 16.14.530) require that a cap be installed over the landfill at closure. This cap must consist of the following:

- a barrier layer to minimize infiltration, consisting of a minimum of 18 inches of earthen material with a permeability equal to or less than the bottom liner of the landfill or natural subsoils present, or no greater than 1 x 10^{-5} cm/sec, whichever is less; and

- an erosion control layer, consisting of a minimum of 6 inches of earthen material capable of sustaining native plant growth.

For areas that stopped receiving waste prior to October 9, 1991, MDHES published closure requirements and recommendations (MDHES, April 3, 1991). These guidelines recommend:

- a cover consisting of a minimum of 24 inches of approved soil with a permeability less than or equal to 1 x 10^{-3} cm/sec;

- contouring of the site to direct runon and runoff away from the landfilled area; and

- revegetation of the site to minimize water infiltration and prevent erosion.

4.2 GROUNDWATER PROTECTION STANDARDS

Groundwater protection standards for the landfill are defined at ARM 16.14.708(5). This regulation states that the groundwater protection standard is established at the maximum contaminant level (MCL) established under the Montana groundwater quality standards, for those constituents for which an MCL has been established. If no MCL has been established, the groundwater protection standard is established as the background concentration of the constituent (as defined at ARM 16.14.706). In all cases, if the background concentration exceeds the MCL, the background concentration becomes the groundwater protection standard.

Per ARM 16.14.708(1)(f), the point of compliance for groundwater standards shall be no more than 150 meters beyond the waste management unit boundary and must be located on land owned by the owner of the disposal unit. BSB is in the process of acquiring the property adjacent to the Old Landfill (the Clark Tailings property) from Inland Properties. As discussed in Section 2.3.3 and shown on Figure 2-5, local groundwater flow is generally to the north. Therefore, the point of compliance is the northern property boundary, along Beeftrail Road. If groundwater protection standards are not exceeded at or beyond the point of compliance, groundwater corrective measures are not required.

5.0 CONTAMINANT ASSESSMENT AND CONCEPTUAL SITE MODEL

Below, available data are evaluated based on the groundwater protection standards and other PRGs discussed in Section 4.0. Constituents of concern (CoC) are identified, and the nature and extent of their occurrence at the site is presented. Based on this information, a conceptual site model of the site was developed.

5.1 GROUNDWATER

As required by ARM 16.14.706(12), a statistical analysis of the groundwater quality data for the landfill was conducted to determine if any contaminants were present at concentrations greater than the groundwater protection standards defined at ARM 16.14.708(5). The first step in the analysis was the examination and treatment of below instrument detection limit data; the second step was to compare downgradient groundwater quality to groundwater protection standards. The methodology, rationale, and results of this evaluation is discussed in the following sections. This evaluation should be considered preliminary, since only two years of data collection activities have been performed. As long-term monitoring data become available, additional statistical comparisons can be performed.

5.1.1 Treatment of Below Instrument Detection Limit Data

The first step in the analysis of these data was to account for data below the limit of detection (BDL data), as required by ARM 16.14.706(13)(e). A significant fraction of these data were below the quantitation limits for the analytical method and cannot simply be excluded from the evaluation. These data were treated in exactly the same manner, both for each analyte and for each detection limit (for those analytes with variable detection limits). The procedure used for these data was to set data reported as below detection (flagged "U") equal to the reported detection limit (e.g., 10U = 10). In most cases, the reported detection limits are below MCLs and other health-based standards; therefore, this simple data treatment is protective of human health and the environment. The only exception to this is bis(2-ethylhexyl)phthalate; the MCL for this constituent is 6 ug/L, but the detection limit is 10 to 11 ug/L. This treatment of BDL data is also conservative, in that it assumes the highest possible concentration for an analyte that was not detected.

Also, the first sampling round, conducted in April of 1993 by SRM, was excluded from this evaluation. This sampling round used different analytical methods, analyzed fewer constituents, and had generally higher detection limits, and hence, were not comparable to the five sampling rounds performed after that date. For the above reasons, especially the higher detection limits, these data were not included.

5.1.2 Comparison of Monitoring Well Groundwater Quality to Groundwater Protection Standards

The procedure for evaluating downgradient water quality used the following methodology. For every constituent detected above the IDL during any sampling round and in any well, both the mean and the median concentrations for each downgradient well were calculated. These concentrations were compared with Federal MCLs established by the EPA (both primary and secondary). If no Federal MCL was established, these concentrations were compared with Montana Human Health Standards (HHSs) established by the MDHES (MDHES, 1994). If neither Federal MCLs nor Montana HHSs exist, the downgradient data were compared to the background data. Collectively, these three concentration comparisons are referred to as groundwater protection standards, as discussed in Section 4.2. In most cases, using this methodology to evaluate downgradient water quality establishes a concentration level that is protective of human health and the environment, as required by ARM 16.14.706(13)(d).

For the comparison to background procedure indicated above, the distribution of analytical data from the background monitoring well (MBMG2) was compared to the data distribution for each of the four downgradient wells. As specified in 16.14.706(12)(a), a parametric, one-way analysis of variance (ANOVA) procedure was used, followed by multiple comparison of means. The comparison of means was performed using both the Least Significant Difference (LSD) method (least conservative-allows experimentwise error rate to increase as "n" increases) and Tukey's (F) method (which limits experimentwise error). Tukey's method for the comparison of means is considered the most useful pairwise comparison because it controls the experimentwise error rate (conservative), yet retains good comparison power; therefore, it was used for determining significant differences between downgradient wells and the background well. Experimentwise error was restricted to 0.05, as specified in ARM 16.14.706(13)(b). It is important to note that this ANOVA comparison is significant even at the low number of samples ("n"= 4 or 5) evaluated. The procedure is robust and significant when applied to smaller values of "n", even when other procedures are not valid at the same small "n". Additional measurements will, of course, increase confidence in the comparison results.

The mean and median concentrations for all wells are presented on Table 5-1 (inorganic constituents) and Table 5-2 (organic constituents). Also indicated on these tables are Federal MCLs, Montana HHSs, mean and median concentrations for blank samples, and an indication of whether the mean or median for each well exceeds the groundwater protection standard. Three noteworthy observations regarding these tables require some explanation.

First, the mean and median concentration of both the background and downgradient wells exceed the MCL for thallium. The thallium background mean is 5 ug/L and the median is 6 ug/L. The downgradient thallium means are 4-9 ug/L and the medians are 5-7 ug/L, compared to the MCL of 2 ug/L. Thallium concentrations vary between <1 and 6 ug/L in the background well and up to 6 ug/L in blank samples. There apparently is a problem with these thallium analyses, possibly an organic interference. Of the five groundwater sampling episodes conducted at the Old Landfill, thallium was detected in the background well on three occasions (the background well was sampled for thallium analysis four times). The concentration of thallium detected in the background well was consistently higher than the associated MCL, and similar to the concentrations detected in the downgradient monitoring wells. Thallium was also detected in the field blank sample on two occasions.

The background well data indicate that the thallium contamination is not attributable to the Old Landfill or the Clark Tailings. Additionally, when thallium was detected in the field blank sample above the MCL, the results were discussed with the laboratory chemists who analyzed the samples. The laboratory chemists indicated that the thallium detects could possibly be false positives caused by instrument interference due to matrix effects (interference due to organic contaminants present in the samples). As a check on the thallium enigma, split samples were collected at the landfill during February of 1995 to be analyzed by independent laboratories, the results are presented on Table 5-3.

Since the laboratory chemists suggested that the thallium detects may be false positives caused by organic interference, the wells selected for split samples correspond with: 1) no expected organic contaminants in the sample (background well MBMG-2); 2) very few expected organic contaminants in the sample (well BSB-A4); and 3) the highest expected amount of organic contaminants in the sample (well BSB-A2). The split sample data indicate that thallium was consistently detected at a higher concentration by the current laboratory and, in fact, thallium was not detected in any of the samples analyzed by the check laboratory. These data indicate that the current laboratory is possibly the source of the thallium contamination that has been observed in the groundwater samples (possible cross-contamination or poor instrument performance on thallium).

Second, the mean and median concentration of the blank samples exceed the MCL for antimony; however, none of the wells exceed groundwater protection standards. The antimony blank mean and median is 10 ug/L, compared to the MCL of 6 ug/L. Clearly, there is also a problem with the

TABLE 5-1
SILVER BOW COUNTY -OLD LANDFILL GROUNDWATER DATA SUMMARY
INORGANIC CONSTITUENTS (ug/L)

ANALYTE	STANDARDS		MBMG-2		BSB-A1		BSB-A2		BSB-A3		BSB-A4		Mean Exceeds Std. or Bkd.	Median Exceeds Std. or Bkd.	BLANK	
	Fed MCL*	HHS	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median			Mean	Median
Metals																
Ag	100(s)	- -	1.7	1.2	2.2	2.0	2.6	4.0	2.6	4.0	2.2	2.0	None	None	0.9	0.4
As	50		2	2	2	2	9	11	35	42	3	3	None	None	1	1
Ba	2,000	1,000	136	135	96	81	68	75	147	171	36	33	None	None	7	5
Be	4	- -	1	1	1	1	1	1	1	1	1	1	None	None	1	1
Cd	5	5	0.2	0.2	1.0	0.3	**7.6**	2.3	0.9	0.1	0.9	0.1	A2 (std)	None	0.1	0.1
Co	- -	- -	10	10	9	10	19	19	12	10	9	10	None	None	10	10
Cr	100	100	9	9	8	8	8	8	8	8	8	8	None	None	9	9
Cu	1,300(a)	1,000	5	5	4	5	4	2	4	2	5	6	None	None	2	2
Fe	300(s)	300	76	35	30	22	**6,454**	**8,210**	**75,740**	**82,000**	12	13	A2,A3 (std)	A2,A3 (std)	12	13
Hg	2	0.14	0.15	0.15	0.16	0.10	0.12	0.10	0.18	0.20	0.18	0.20	None	None	0.10	0.10
Ni	100	100	14	13	14	14	32	20	14	14	14	14	None	None	13	10
Pb	15(a)	15	1	1	1	1	1	1	1	1	1	1	None	None	1	1
Sb	6	14	5	4	4	3	4	3	3	3	4	3	None (blk)	None (blk)	**10**	**10**
Se	50	50	1	1	1	1	1	1	1	1	2	1	None	None	1	1
Tl	2	- -	**5**	**6**	**5**	**5**	**6**	**6**	**9**	**7**	**4**	**5**	All (std)	All (std)	1	1
V	- -	- -	10	11	6	4	6	4	7	7	8	9	None	None	4	4
Zn	5,000(s)	5,000	17	15	15	16	**6,304**	2,090	247	90	15	10	A2 (std)	None	10	10
Inorganics																
Chloride	250,000(s)	- -	59,750	59,000	16,200	15,000	126,200	126,000	44,600	42,000	9,200	6,000	None	None		
Sulfate	250,000(s)	- -	132,300	135,000	118,600	100,000	**651,800**	**288,000**	69,200	51,000	171,400	162,000	A2 (std)	A2 (std)		
Nitrate	10,000	- -	4,885	5,025	488	610	66	50	50	50	1,012	1,100	None	None		
COD	- -	- -	43,250	36,500	56,600	44,000	186,200	115,000	98,800	92,000	18,800	20,000	None	None		
SC	- -	- -	705	701	508	450	**1,722**	**1,650**	**1,124**	**1,150**	625	586	A2,A3(bkd)	A2,A3(bkd)		

* MCL definitions: a = action level, not an MCL; s = secondary MCL (asthetics)
BDL values calculated as equal to detection limit (e.g. <10 = 10)
Bolded values exceed established standards (significantly above background for constituents with no standard)

TABLE 5-2
SILVER BOW COUNTY -OLD LANDFILL GROUNDWATER DATA SUMMARY
ORGANIC CONSTITUENTS (ug/L)

ANALYTE	STANDARDS		MBMG-2		BSB-A1		BSB-A2		BSB-A3		BSB-A4		Mean Exceeds Std. or Bkd.	Median Exceeds Std. or Bkd.	BLANK	
	MCL	HHS	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median			Mean	Median
Acetone			50	50	56	50	50	50	69	50	50	50	None	None	51	50
Benzene	5	1.2	1.0	1.0	0.8	1.0	1.4	1.6	2.8	2.8	1.0	1.0	None	None	1.0	1.0
Carbon Disulfide			1.0	1.0	0.9	0.9	0.9	1.0	0.8	0.8	5.5	3.4	None	None	0.7	0.7
Chloroform		5.7	0.9	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	None	None	1.0	1.0
Chloroethane		- -	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.2	1.0	1.0	None	None	1.0	1.0
Chloromethane		- -	1.0	1.0	1.0	1.0	1.3	1.0	1.0	1.0	0.9	1.0	None	None	1.2	1.0
1,4-Dichlorobenzene-8260	75	75	1.0	1.0	1.0	1.0	3.5	3.8	4.0	4.4	1.0	1.0	None	None	1.0	1.0
Dichlorodifluoromethane		6900	1.0	1.0	0.6	0.7	20.3	19.0	1.3	1.3	1.0	1.0	None	None	1.0	1.0
Dichlorofluoromethane			1.0	1.0	1.0	1.0	**15.0**	**15.0**	0.9	0.9	1.0	1.0	A2 (bkd)	A2 (bkd)	1.0	1.0
1,1-Dichloroethane		- -	1.0	1.0	1.0	1.0	**11.4**	**12.5**	1.1	1.1	1.0	1.0	A2 (bkd)	A2 (bkd)	1.0	1.0
1,2-Dichloroethane	5	0.38	1.0	1.0	1.1	1.0	2.7	2.0	1.6	1.0	1.4	1.0	None	None	1.9	1.0
1,1-Dichloroethene	7	0.57	1.0	1.0	1.0	1.0	0.5	0.5	1.0	1.0	1.0	1.0	None	None	1.0	1.0
cis-1,2-Dichloroethene	70	70	1.0	1.0	0.8	0.9	**156.8**	**170.0**	46.8	45.5	1.0	1.0	A2 (std)	A2 (std)	1.0	1.0
trans-1,2-Dichloroethene	100	100	1.0	1.0	1.0	1.0	1.4	1.4	0.6	0.7	1.0	1.0	None	None	1.0	1.0
1,2-Dichloropropane	5	0.52	1.0	1.0	1.0	1.0	2.0	2.2	1.0	1.0	1.0	1.0	None	None	1.0	1.0
Ethylbenzene	700	700	1.0	1.0	1.0	1.0	1.0	1.0	2.6	1.9	1.0	1.0	None	None	1.0	1.0
Methylene Chloride	5	4.7	1.0	1.0	1.0	1.0	1.7	1.7	1.0	1.0	1.0	1.0	None	None	1.0	1.0
Tetrachloroethene	5	0.8	1.0	1.0	1.8	1.7	**6.6**	**6.7**	0.7	0.8	1.0	1.0	A2 (std)	A2 (std)	1.0	1.0
1,1,1-Trichloroethane	200	200	1.0	1.0	1.0	1.0	3.0	1.0	1.7	1.0	1.0	1.0	None	None	1.0	1.0
Toluene	1000	1000	1.0	1.0	0.7	0.8	1.0	1.0	0.8	1.0	0.6	0.6	None	None	0.8	1.0
Trichloroethene	5	2.7	1.0	1.0	0.8	0.9	**14.3**	**14.0**	1.3	1.2	1.0	1.0	A2 (std)	A2 (std)	1.0	1.0
Trichlorofluoromethane		10000	1.0	1.0	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	None	None	1.0	1.0
Vinyl Chloride	2	2	1.0	1.0	1.0	1.0	**3.2**	**3.9**	1.1	1.1	1.0	1.0	A2 (std)	A2 (std)	1.0	1.0
m+p Xylenes	10000	10000	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	None	None	1.0	1.0
o-Xylene	10000	10000	1.0	1.0	1.0	1.0	1.0	1.0	0.6	0.6	1.0	1.0	None	None	1.0	1.0
1,4-Dichlorobenzene-8270	75	75	10.5	10.5	10.3	10.0	2.7	2.8	2.5	2.3	10.5	10.5	None	None	10.3	10.0
Diethylphthalate		23000	10.5	10.5	10.3	10.0	1.8	1.7	4.8	2.1	10.5	10.5	None	None	10.3	10.0
Di-n-butylphthalate		2700	10.5	10.5	10.3	10.0	6.9	10.0	10.3	10.0	10.5	10.5	None	None	7.2	10.0
bis(2-ethylhexyl)phthalate	6	1.8	**10.5**	**10.5**	**7.3**	**10.0**	4.1	1.4	**10.3**	**10.0**	**7.1**	**7.1**	All (std)*	All (std)*	**8.1**	**10.0**
Acenaphthene		20	10.5	10.5	10.3	10.0	10.0	10.0	7.2	10.0	10.5	10.5	None	None	10.3	10.0

BDL values calculated as equal to detection limit (e.g. <10 = 10)
Bolded values exceed established standards (significantly above background for constituents with no standard)
* Note: Detection limit for this constituent (10-11 ug/L) is above the MCL (6 ug/L).

TABLE 5-3: SPLIT SAMPLE RESULTS - OLD BUTTE-SILVER BOW LANDFILL

DATE SAMPLED: FEBRUARY 1, 1995

SAMPLE NUMBER WELL	BSB-GW-O1 MBMG-2		BSB-GW-O3 BSB-A4		BSB-GW-O5 BSB-A2	
ANALYTE (units):	Current Laboratory	Check Laboratory	Current Laboratory	Check Laboratory	Current Laboratory	Check Laboratory
Antimony (mg/L)	0.009	<0.005	0.006	<0.005	<0.003	0.006
Cadmium (mg/L)	<0.0001	<0.0001	0.0001	<0.0001	0.0013	0.0011
Thallium (mg/L)	0.006	<0.002	0.005	<0.002	0.006	<0.002

antimony analyses, possibly a filter/tubing contribution. Similar to thallium, antimony has been observed at relatively high concentrations in background well samples, as well as in the field blank sample during several sampling episodes at the landfill.

The background well data indicate that the antimony contamination is not attributable to the Old Landfill or the Clark Tailings. However, as a check on the antimony enigma, split samples were collected at the landfill during February of 1995 to be analyzed by independent laboratories, the results are presented on Table 5-4. The data indicate that antimony is not in close agreement between the two laboratories; however, in general, antimony was detected at a higher concentration by the current laboratory compared to the check laboratory. As an additional check on the antimony enigma, separate field blank samples were collected during March of 1995. One of the blank samples consisted of deionized water filtered in the field in the usual manner (the same filtering equipment used to filter the groundwater samples), the other blank sample consisted of deionized water transferred directly into the sample container (not filtered). These data presented in Table 5-4 indicate that the antimony contamination is most likely attributable to the filter or the tubing attached to the peristaltic pump used for field filtering. The standard operating procedure for field filtering groundwater samples includes decontamination of the pump tubing between samples; however, these data indicate that cross-contamination is most likely occurring and the pump tubing should be replaced prior to each sampling episode.

Lastly, bis(2-ethylhexyl)phthalate appears to exceed the groundwater protection standards in all wells except BSB-A2; however, the MCL for this constituent is 6 ug/L, while the detection limit is 10 to 11 ug/L. This leads to mean and median concentrations that appear to exceed standards, when actually all of these data are below the limits of detection. Therefore, this constituent is not regarded as having exceeded the groundwater protection standard.

Exceedences of groundwater protection standards (as defined in Section 4.2) were present in downgradient monitoring wells (mean or median) for the following inorganic constituents:

- Well BSB-A1: None.
- Well BSB-A2: Cd (mean only), Fe, Zn (mean only), and sulfate.
- Well BSB-A3: Fe.
- Well BSB-A4: None.

Of note for inorganics is that the mean concentrations for Cd and Zn in Well BSB-A2 exceed standards, while the median concentrations do not. This indicates that the distribution for these constituents in this well may be skewed by one or more high concentration data points; additional samples will assist in determining whether groundwater protection standards are exceeded in a statistically significant fashion. Due to the interferences noted above, thallium is not designated as exceeding the groundwater protection standards at the site.

Exceedences of groundwater protection standards for the following organic constituents were present in monitoring Well BSB-A2:

TABLE 5-4: OLD BUTTE-SILVER BOW COUNTY LANDFILL BLANK SAMPLE COMPARISON

DATE SAMPLED: MARCH 1, 1995

ANALYTE (units):	FIELD BLANK (Filtered)	FIELD BLANK (Not Filtered)
Antimony	0.010	<0.003
Arsenic	<0.001	<0.001
Barium	<0.005	<0.005
Beryllium	0.0001	0.0001
Cadmium	<0.0001	<0.0001
Chromium	<0.009	<0.009
Cobalt	<0.010	<0.010
Copper	0.002	<0.001
Iron	<0.013	<0.013
Lead	<0.001	<0.001
Mercury	<0.0001	<0.0001
Nickel	<0.01	<0.01
Selenium	<0.001	<0.001
Silver	<0.0004	<0.0004
Thallium	<0.001	<0.001
Vanadium	<0.004	<0.004
Zinc	<0.01	<0.01

- 1,1-Dichloroethane;
- cis-1,2-Dichloroethene;
- Tetrachloroethene;
- Trichloroethene; and
- Vinyl chloride.

Based on the preceding information, the following inorganics have been identified as groundwater CoC: cadmium, iron, zinc, and sulfate. Specific conductance is regarded as a general indicator of groundwater quality, and is not considered a CoC in and of itself. Organic CoC are: 1,1-dichloroethane; cis-1,2-dichloroethene; tetrachloroethene; trichloroethene; and vinyl chloride.

5.1.3 Downgradient Water Quality

To determine if there were significant impacts on downgradient water quality, samples were collected from the some of the downgradient water wells shown on Figure 2-5. Samples from the Blankenship, the Crematorium, and cemetery-middle wells were analyzed for volatile organic compounds. Samples from the Reap and Blankenship wells were analyzed for heavy metals. Results are summarized on Table 5-5 and are included in Appendix B. No CoC from the site were detected above groundwater protection standards in the downgradient wells.

5.2 SURFACE WATER

Available surface water data for the site consist of four samples collected by MBMG personnel between May 15, 1991, and August 20, 1992. Samples were collected above and below the Old Landfill. The upgradient sampling location is described as Grove Gulch, upgradient of the landfill. The downgradient sampling location is described as Grove Gulch, downgradient of the landfill, near Montana Street. This downgradient sample is not only downgradient of the landfill, but is also downgradient of a large area east of the landfill, including some portions of Timber Butte, a livestock facility, a trucking facility, and a residential area. Analytical data are included in Appendix A and summarized in Table 5-6. By comparing upgradient to downgradient concentrations, it appears that the site does not significantly degrade surface water quality. While iron and manganese concentrations increase slightly between the upgradient and downgradient sites, the rise could be attributed to contact with steel pipe associated with the Grove Gulch diversion or other factors. Metals present in the Clark Tailings that are potentially mobile, particularly copper and zinc, do not increase downgradient of the site.

Some of the metals concentrations detected exceed surface water quality standards as defined by Water Quality Bureau Circular 7 (MDHES, 1994). The iron human health standard of 0.3 milligrams per liter (mg/L) is exceeded at the downgradient location. The downgradient sample means do not exceed the chronic aquatic life standard (CALS) for iron of 1 mg/L. Manganese upgradient and downgradient of the site exceed the HHS of 50 ug/L. There is no CALS for manganese.

TABLE 5-5: DOWNGRADIENT WELL SAMPLING RESULTS

SAMPLE NUMBER WELL ANALYTE (units):	RE-3 K. REAP	BL-4 BLANKENSHIP	CR-1 CREMATORIUM	CE-2 CEMETERY MIDDLE	DRINKING WATER MCL
DISSOLVED METALS (mg/L)					
Antimony	0.009	<0.002	NR	NR	0.006
Arsenic	0.002	0.002	NR	NR	0.05
Barium	0.017	0.090	NR	NR	2
Beryllium	0.0003	<0.0001	NR	NR	0.004
Cadmium	0.0002	<0.0001	NR	NR	0.005
Chromium	<0.009	<0.009	NR	NR	0.1
Cobalt	<0.010	<0.010	NR	NR	
Copper	<0.002	0.016	NR	NR	
Iron	10.7	0.088	NR	NR	
Lead	0.003	<0.001	NR	NR	(0.015)*
Mercury	<0.0001	<0.0001	NR	NR	0.002
Nickel	<0.01	<0.01	NR	NR	
Selenium	<0.001	<0.001	NR	NR	0.05
Silver	<0.001	<0.001	NR	NR	
Thallium	0.003	<0.001	NR	NR	0.002
Vanadium	0.006	0.006	NR	NR	
Zinc	0.073	0.539	NR	NR	
EPA METHOD 8260 (ug/L)					
Cloromethane	NR	3.0	1.6	2.6	
Chloroform	NR	<1.0	<1.0	<1.0 (0.33J)	
1,2-Dichloroethane	NR	1.2	<1.0 (0.65J)	<1.0 (0.74J)	5
Tetrachloroethene	NR	<1.0	<1.0	<1.0 (0.35J)	5

* = Value is an action level, not a MCL.
NR = Not Requested
J = Estimated Quantity. Analyte present, but less than the practical quantitation limit (PQL).

TABLE 5-6: SELECTED DATA FROM MBMG GROVE GULCH SAMPLING EVENTS

		FIELD PARAMETERS							CATIONS/ANIONS (mg/L)										DISSOLVED METALS (ug/L)					
SAMPLE LOCATION	DATE	Q (gpm)	pH	Eh (mv)	Specific Cond. (umhos/cm)	Temp. (C)	Hardness (mg/L)	Alkalinity (mg/L)	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO3-N	F	As	Cu	Li	Pb	Sr	Zn
UPGRADIENT	05/15/91	315	8.1	97	395	9.5	130.1	78.2	37.9	8.6	15.3	4.7	0.15	0.06	7.3	62.1	0.15	0.54	5.3	21	12	<40	228	176
UPGRADIENT	03/06/92	180	8.2	27	276	3.3	106.5	73.6	30.6	7.3	11.8	6.8	0.25	0.17	6.7	59.2	0.23	0.5	8	11	<6	1	191	20
UPGRADIENT	06/19/92	68	7.6	249	360	17	181.1	132.1	53.4	11.6	16.2	4.3	0.07	0.09	7.8	67.9	0.07	1.22	6.9	12	20	<100	311	<10
UPGRADIENT	08/20/92	2	7.7	-67	372	19	167.9	150.9	49.1	11	16.5	6.4	0.1	0.04	5.7	51.6	0.1	0.54	6.4	18	<6	<3	272	20
UPGRAD, ARITHMETIC MEAN		141			351	12.2	146.4	108.7	42.8	9.6	15	5.6	0.14	0.09	6.9	60.2	0.14	0.7	6.7	16	11	36	251	57
UPGRAD, GEOMETRIC MEAN		53			348	10	143.3	103.5	41.8	9.5	14.8	5.4	0.13	0.08	6.8	59.9	0.12	0.65	6.6	15	10	10	246	29
DOWNGRADIENT	05/15/91	495	7.6	139	440	11.7	167.4	115.2	48.9	11	18.6	5.6	0.6	0.83	15.4	72.3	0.1	0.78	7.2	19	9	<40	280	53
DOWNGRADIENT	03/06/92	180	8.1	N/A	385	6.5	152.9	107.3	44.4	10.2	15.6	7.5	0.53	0.76	13.8	72.6	0.36	0.67	7	5	6	<1	249	30
DOWNGRADIENT	06/19/92	135	7.3	229	469	16.9	213.3	162.3	61.2	14.7	20.7	6.6	0.18	1.54	20.7	70.9	0.05	1	10	<10	7	<100	350	20
DOWNGRADIENT	08/20/92	22	7.2	-27	540	12.1	232	192.7	67.2	15.6	22.1	6.6	2.55	3.93	26	67	1.28	0.69	14.7	2	<6	<1	376	36
DOWNGRAD, ARITHMETIC MEAN		208			459	11.8	191.4	144.4	55.4	12.9	19.3	6.6	0.97	1.77	19	70.7	0.45	0.79	9.7	9	7	36	314	35
DOWNGRAD, GEOMETRIC MEAN		128			455	11.2	188.7	140.2	54.7	12.7	19.1	6.5	0.62	1.4	18.4	70.7	0.22	0.77	9.3	7	7	8	309	33

SOURCE: Montana Bureau of Mines and Geology unpublished data (MBMG, 1995).

NOTES:
1. Upgradient = Grove Gulch above landfill.
2. Downgradient = Grove Gulch below landfill, near Montana St.
3. < = not detected at the reported detection limit.
4. Undetected parameters were considered present at their detection limit when calculating means.

5.3 CONCEPTUAL SITE MODEL

The conceptual site model presents the potential routes of human exposure to the waste materials at the site under existing conditions.

Wastes present at the site generally are covered with native soils. However, in some areas cover soils have eroded away and tailings and debris are present at the surface. Therefore the possibility of exposure, via dermal contact, ingestion, and/or inhalation of airborne particulates, does exist. Access to the site is restricted, however, by a wire-strand fence. Therefore, the current potential to exposure in this manner is considered limited. However, if the site is developed as a recreational facility, the potential for exposure may increase.

Existing data collected by MBMG personnel (see Section 5.2) indicates that surface water in Grove Gulch is not degraded by the site. However, there is evidence at the site that surface water is cutting through waste materials (including tailings) during runoff events. Discharge from the site enters either the Grove Gulch Sedimentation Pond or the Timber Butte Sedimentation Basin. These structures remove the majority of suspended solids, and associated metals, from the water column.

Waste materials at the site have resulted in the contamination of groundwater beneath the site to levels exceeding certain groundwater protection standards (Section 5.1). However, it is not known if groundwater protection standards have been exceeded at the point of compliance or if this contamination poses a potential exposure pathway. The contaminated well (BSB-A2) is over 700 feet south of the point of compliance (the northern border of the site). The monitoring well nearest to the point of compliance (BSB-A1) does not contain contaminants at concentrations exceeding groundwater protection standards. Groundwater protection standards have not been exceeded in downgradient wells that were sampled as part of this CMA (Section 5.1.3). Furthermore, downgradient wells are used predominately for irrigation. If the wells are used only for irrigation, there is a very limited potential for exposure. The organic groundwater CoC are all very volatile in nature, and would be expected to be volatilized during irrigation. The mass of organics transferred to the gaseous phase would most likely be very small (based on the concentrations detected), so the possibility of exposure via inhalation is negligible. Inorganic CoC in the groundwater would be retained in the aqueous phase during irrigation. These CoC would then be attenuated by the soils as the water infiltrates, uptaken by the vegetation, or routed back to the aquifer. The potential for exposure would be minimal.

6.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

Technology types and remedial process options are identified, described, and screened in Section 6.1. In Section 6.2, feasible technologies are assembled and developed as reclamation alternatives and are subjected to an initial/preliminary screening based on effectiveness, implementability, and cost. The purpose of the initial screening of alternatives is to identify those alternatives appropriate for a subsequent, detailed analysis. The initial screening also helps identify technology-specific data needs for detailed site characterization.

6.1 IDENTIFICATION AND SCREENING OF RECLAMATION TECHNOLOGIES AND PROCESS OPTIONS

The purpose of identifying and screening technology types and process options is to eliminate those technologies that are obviously infeasible while retaining potentially effective options. General response actions are progressively refined into technology types and process options. The process options are screened, and those retained are used to develop corrective measures alternatives. General response actions, technology types, and process options are briefly discussed in this section. General response actions potentially capable of meeting the reclamation objectives are identified in Table 6-1.

In Table 6-2, the screening rationale that was used to eliminate or retain the various remedial process options for potential application at the Old Landfill/Clark Tailings site is presented. Screening was based on the available site data. This includes the fact that groundwater protection standards have not been exceeded beyond the point of compliance (Section 5.3).

6.1.1 No Action

Under the no action option, no future remediation or monitoring would occur at the site. The no action response is a stand-alone response that is used as a baseline against which candidate remedial alternatives are compared.

6.1.2 Institutional Controls

Some institutional controls (deed restrictions) are required under Montana solid waste rules for the closure of the landfill. Upon agreement, deed restrictions are to be recorded with the transfer of land from Inland Properties to BSB for the Clark Tailings site. Land use/zoning restrictions could limit the potential future uses for the land in the event of a sale. Other institutional controls could include access restrictions (fencing) or instituting groundwater use and development restrictions.

This type of action does not, in itself, achieve a specific clean-up goal. Institutional controls may be considered alone or in addition to reclamation technologies to accompany other reclamation alternatives.

6.1.3 Containment

Containment is used primarily to reduce the mobility of contaminants by creating a barrier that prevents transport of waste from the contaminated source to the surrounding media. Containment technologies may include capping, revegetation, runon/runoff control. Other containment technologies include a variety of technologies designed to prevent the exposure of groundwater to the contaminated media, or the migration of contaminated groundwater from the site.

TABLE 6-1

GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS AT THE OLD BUTTE LANDFILL/CLARK TAILINGS SITE

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE	PROCESS OPTIONS
No Action	Not Applicable	Not Applicable
Institutional Controls	Access Restrictions	Fencing Land Use Control Groundwater Use Restrictions
Containment	Capping	Native Soil Cover Low Permeabilty Soil Cover Geosynthetic Cover Multimedia Cover Asphalt/Concrete Cover Wet Closure
	Surface Controls	Consolidation Grading Revegetation Erosion Protection Run-on/Run-off Control
	Vertical Barriers	Slurry Wall Vibrating Beam Grout Curtains Sheet Piling Permeability Reduction Agents Ground Freezing
	Horizontal Barriers	Block Displacement Grout Injection Ground Freezing Liners
	Sediment Control	Curtain Barriers Cofferdams Capping Barriers Sandbags Settling Basins
	Dust Suppression	Watering Polymers and Foams Membranes Hygroscopic Agents
Removal	Solids Removal	Excavation Partial Excavation

TABLE 6-1 (Cont'd)

GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS AT THE OLD BUTTE LANDFILL/CLARK TAILINGS SITE

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE	PROCESS OPTIONS
	Liquids Removal	Pumping Bailing Gravity/Siphon Dredging
	Groundwater Collection	Wells Trench Drains
	Soil Vapor Extraction	Passive Extraction Active Extraction
	Landfill Gas Extraction	Passive Extraction Active Extraction
Solids Treatment	Physical/Chemical Treatment	Chemical Fixation Neutralization Oxidation Chemical Reduction Water Leaching Solvent Leaching Land Farming Soil Washing Acid Extraction Alkaline Leaching
	Thermal Treatment	Incineration Vitrification
	In Situ Treatment	Stabilization/Solidification Soil Flushing Vitrification Neutralization Oxidation Precipitation Bioremediation Thermal Evaporation Steam Stripping Soil Vapor Extraction

TABLE 6-1 (Cont'd)

GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS AT THE OLD BUTTE LANDFILL/CLARK TAILINGS SITE

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE	PROCESS OPTIONS
Non-Solids Treatment	Physical Treatment	Coagulation/Flocculation Non-Aqueous Phase Liquids Separation Flotation Filtration Adsorption Membrane Processes Freeze Crystallization Air Stripping Steam Stripping Evaporation Distillation Liquid-Liquid Extraction Critical Fluid Extraction
	Chemical Treatment	Neutralization Precipitation Ion Exchange Oxidation Reduction Organic Chemical Dechlorination Irradiation
	Biological Treatment	Aerobic Processes Anaerobic Processes Facultative Processes Land Treatment Wetland Treatment Publicly-Owned Treatment Works
	Thermal Treatment	Incineration Co-Disposal Processes Pyrolosis Wet Air Oxidation
	In Situ Treatment	Air Sparging Soil Vapor Extraction Bioremediation Landfill Gas Extraction
Monitoring	Monitoring	Monitoring

TABLE 6-2

OLD BUTTE LANDFILL/CLARK TAILINGS
REMEDIAL TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
NO ACTION	None	Not Applicable	No Action	Alternative is retained as a basis for comparison.
INSTITUTIONAL CONTROLS	Access Restrictions	Fencing	Security fences installed around contaminated areas to limit access.	Potentially effective in conjunction with other technologies readily implementable.
		Land Use Control	Restrictions to control current and future land use.	Potentially effective in conjunction with other process options. Readily implementable.
		Groundwater Use Controls	Restrictions on the development and use of the aquifer in the vicinity of the site.	Potentially applicable at the site to prevent development and use of contaminated groundwater.
CONTAINMENT	Capping	Native Soil Cover	Application of soil and establishment of vegetative cover to stabilize surface of contamination source.	Surface infiltration and runoff potential would be reduced, but not prevented. Readily implementable. Required, at a minimum, on portions of landfill which received waste prior to October 9, 1991.
		Low Permeability Soil Cover	Application of compacted low permeability soil (clay) to provide a barrier to prevent infiltration of water.	Surface infiltration reduced. Readily implementable, usually in conjunction with a vegetated native soil cover to prevent erosion and freezing. Required on portions of landfill which received waste after October 9, 1991.
		Geosynthetic Cover	Application of a geosynthetic membrane (such as HDPE or PVC) over areas of contamination.	Surface infiltration reduced. Potentially effective at source control and readily implementable.
		Multimedia Cap	Compacted clay and geosynthetic membrane materials covered with soil/vegetation over areas of surface contamination.	Surface infiltration minimized. Potentially effective for source control and readily implementable.
		Asphalt/Concrete Cover	Application of layer asphalt or concrete over areas of surface contamination.	Limited feasibility due to remoteness of area and steep slopes. Would require extensive grading and compaction.
		Wet Closure	Construct dam to flood tailings with water and provide anaerobic environment to limit oxidation/migration of contaminants.	Not effective for landfill source control. Not applicable to tailings due to local topography.
	Surface Controls	Consolidation	Combining similar waste types in a common area.	Potentially applicable and effective in conjunction with other process options. Readily implementable.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS REMEDIAL TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
		Grading	Redefine topography to reduce severe slopes and increase shallow slopes for managing surface water infiltration, run-on, runoff, and erosion.	Potentially effective in conjunction with other process options. Readily implementable.
		Revegetation	Adding amendments to waste or waste cover and seeding with appropriate vegetative species to establish an erosion resistant ground surface and an evapotranspirative layer to prevent infiltration.	Potentially effective. Readily implementable.
		Erosion Protection/Run-on, Runoff Control	Erosion resistant materials/fabrics placed directly on waste sources or covers to reduce surface erosion. Surface water diversion structures constructed to direct runoff away from waste source(s).	Potentially effective at reducing contaminant mobility. Readily implementable.
	Vertical Barriers	Slurry Wall	Trench around contaminated area is excavated and backfilled with a low permeability slurry.	Potentially effective at preventing subsurface infiltration of upgradient groundwater. Difficult to implement because of uncertainties about depth of fill and depth to groundwater. High cost.
		Vibrating Beam	Steel beam barrier is driven into ground and then withdrawn as a low permeability material (i.e. bentonite) is injected.	"
		Grout Curtains	Grout is injected around contaminated area to form low permeability subsurface barrier.	"
		Sheet Piling	Steel sheet piling is driven around contaminated areas to an impermeable subsurface barrier.	"
		Permeability Reduction Agents	Grout or polymer is injected into the soil matrix to reduce permeability.	Potentially effective at preventing subsurface infiltration of upgradient groundwater. However, process is experimental and not proven to be effective.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS REMEDIAL TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
		Ground Freezing	Coolant is circulated through refrigeration pipes to freeze the ground, creating an impermeable subsurface barrier.	Potentially effective at preventing subsurface infiltration of upgradient groundwater. Difficult to implement because of uncertainties about depth of fill and depth to groundwater. Known to be not cost-effective.
	Horizontal Barriers	Block Displacement	Injection of slurry creates a horizontal barrier (liner) below the contamination source.	Experimental process is not proven to be effective.
		Grout Injection	Grout injected through borings to create a horizontal barrier below waste.	"
		Ground Freezing	Ground below contamination source is frozen by circulating coolant.	"
		Liners	Liners placed to minimize transfer of leachate from contamination source into underlying soils and/or aquifers.	Proven effective. However, not implementable at this site due to volume and depth of waste in place.
	Sediment Control	Curtain Barriers	Curtains placed in water bodies to prevent migration of sediments.	Not applicable to waste forms at site.
		Cofferdams	Cofferdams installed to isolate areas of contaminated sediments.	"
		Capping Barriers	Contaminated sediments are capped to prevent migration.	"
		Settling Basins	Basins are constructed to detain or retain flow to allow entrained solids from migrating from site.	Potentially applicable to prevent migration of contaminated materials eroded by run-off. Process is currently being applied at the site.
	Dust Suppression	Watering	Water sprayed over area to prevent dust generation.	Potentially effective to prevent airborne migration of contaminants, particularly during construction activities.
		Polymers and Foams	Organic agents, polymers, and/or foams sprayed over area to prevent dust generation	Potentially effective to prevent airborne migration of contaminants, particularly during construction activities. Less cost-effective than watering.
		Membranes	Membranes or tarps are spread over area to prevent dust generation.	Potentially effective, but not implementable at this site.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
REMEDIAL TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
		Hygroscopic Agents	Hygroscopic salts are added to soils to attract water to the soils, preventing dust generation.	Potentially effective to prevent airborne migration of contaminants, particularly during construction activities. Less cost-effective than watering.
REMOVAL	Solids Removal	**Excavation**	Removal of solid contamination source with conventional excavating equipment.	Potentially effective, but not implementable at this site due to volume of waste present.
		Partial Excavation	Excavation of solids from sensitive areas with conventional excavating equipment.	Potentially effective and implementable.
	Liquids Removal	**Pumping**	Large quantities of free liquids are removed with pumps.	Not applicable to the waste forms at this site.
		Bailing	Small amounts of free liquids or sludges are removed with bailers.	"
		Gravity/Siphon	Liquids are removed from tanks or ponds by draining or siphoning.	"
		Dredging	Sludges and associated liquids are dredged from water bodies.	"
	Groundwater Collection	**Wells**	Wells are installed in the aquifer to collect and remove (via pumping or bailing) contaminated groundwater.	Not applicable to the waste forms present at the site. Groundwater protection standards are not exceeded in downgradient wells.
		Trench Drains	Gravel-filled trenches collect contaminated groundwater.	Not applicable to the waste forms present at the site. Groundwater protection standards are not exceeded in downgradient wells.
	Soil Vapor Extraction	**Passive Extraction**	Passive soil vents are installed to intercept soil vapors and vent them to the atmosphere.	Not applicable to the known waste forms at the site.
		Active Extraction	Wells and/or trenches are installed and placed under vacuum to soil vapors.	"
	Landfill Gas Extraction	**Passive Extraction**	Passive soil vents are installed in and around a landfill to intercept landfill gas and vent it to the atmosphere.	"
		Active Extraction	Wells and/or trenches are installed in and around a landfill and placed under vacuum to collect landfill gas.	"

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
REMEDIAL TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
SOLIDS TREATMENT	Physical/Chemical Treatment	Chemical Fixation	Hazardous solids are mixed with reagents (often portland cement and pozzolonic materials) to produce a non-leachable product.	Potentially effective to inorganic solids (Clark Tailings). However, would require extensive testing and appropriate final disposal. Not readily implementable and cost due to volume of waste requiring removal and treatment.
		Neutralization	Acid added to alkaline wastes or base added to acidic wastes to adjust the pH to near neutral.	Potentially effective on acidic tailings, particularly as a buffer zone to raise pH of any infiltrating surface water to prevent leaching of tailings. Readily implementable.
		Oxidation	Oxidizing agents added to waste to oxidize organic contaminants.	Potentially effective to organic wastes. Not implementable due to volume of solid waste present and heterogenous nature of solid waste.
		Chemical Reduction	Reducing agents added to waste to stabilize metals by reducing them to less mobile oxidation states.	Potentially effective on oxidized inorganic solids. Not implementable due to volume of the tailings media present at the site.
		Land Farming	Solid media contaminated with organic wastes are mixed with soil by tilling and the wastes are degraded by volatilization, photolysis, and biological processes.	Not applicable to the waste forms present at the site.
		Soil Washing	Hazardous constituents are separated from solid media via dissolution (in water or solvents) and subsequent precipitation.	Effectiveness is questionable. Potential exists to increase mobility by providing partial dissolution of contaminants. More difficulty encountered by wider range of CoCs.
		Acid Extraction	Hazardous constituents are leached from solid media with acid and recovered via subsequent precipitation.	Effectiveness is questionable. Sulfides present in tailings would be acid soluble under extreme conditions of temperature and pressure. Not readily implementable due to volume of the tailings media present at the site.
		Alkaline Leaching	An alkaline solution is used to leach contaminants from solid media.	Effectiveness is not well-documented. Not readily implementable due to volume of the tailings media present at the site.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
REMEDIAL TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
	Thermal Treatment	Incineration	Solid media are incinerated in a fluidized bed kiln, rotary kiln, or multi-hearth kiln. Organic hazardous constituents are destroyed. Inorganic constituents are volatilized or retained in the solids (ash) fraction.	Potentially effective. However, waste streams would require further treatment. Not readily implementable due to the volume of waste present at the site and high cost.
		Vitrification	Extremely high temperatures used to melt and/or volatilize all components of the solid media. The molten material containing contaminants is cooled and vitrified into a stable, unleachable form.	Further treatment is required to treat process byproducts (off-gases). Not readily implementable due to the volume of waste present at the site and high cost.
	In Situ Treatment	Stabilization/ Solidification	Solid media waste constituents are solidified and/or stabilized in place by mixing with stabilizing agents. Can be accomplished in situ with deep soil mixing techniques.	Potentially effective on tailings. However, extensive treatability testing is required. Potentially implementable on tailings, but cost-prohibitive.
		Soil Flushing	Acid/base reagents or chelating agents injected into solid media to solubilize metals. The solution is then extracted using dewatering techniques.	Effectiveness not certain. Innovative process currently at pilot stage. Potential exists that metals will be solubilized and not collected, thus leaching to the aquifer and exacerbating the groundwater contamination problem.
		Vitrification	Solid media are subjected to extremely high temperatures in place. During cooling, material is vitrified into a stable, unleachable form.	New technology at pilot-scale. Difficulties may be encountered in establishing proper process control. Potentially implementable, but cost-prohibitive.
		Neutralization	Substances applied or injected into a contaminated site to adjust the pH of the waste.	Potentially effective on tailings to raise pH to minimize mobilization of metals. Readily implementable.
		Oxidation	Oxidizing agents added to waste to oxidize organic contaminants.	Potentially effective to organic wastes. Not implementable due to volume of solid waste present and heterogenous nature of solid waste.
		Precipitation	Substances applied to soils to promote precipitation of metals.	Experimental process has not been proven effective.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS REMEDIAL TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
		Bioremediation	Microbiological degradation of hazardous substances. Conditions are controlled through amendments to enhance biological activity, thus increasing the rate of degradation.	Not effective on the solid waste media present at the site, considering the heterogenous nature of the waste.
		Thermal Evaporation	Solid waste media are heated electronically, volatilizing organic hazardous substances.	Not effective on the solid waste media present at the site, considering the heterogenous nature of the waste. Cost-prohibitive.
		Steam Stripping	VOCs are removed from solid media (soils) by steam. Steam is injected through wells, routed through the contaminated media, and extracted through different wells.	Not applicable to known waste forms at the site.
		Soil Vapor Extraction	Passive and/or active soil vents are installed to intercept soil vapors and vent them to the atmosphere.	Not applicable to known waste forms at the site.
NON-SOLIDS TREATMENT	Physical Treatment	Coagulation/ Flocculation	Suspended solids are removed by addition of flocculents to waste stream. Small particles are collected on the flocculent and then removed by gravity.	Not applicable to known waste forms at the site.
		Non-Aqueous Phase Liquids Separation	Non-aqueous phase liquids are separated from water by gravity (i.e. oil-water separation).	Not applicable to known waste forms at the site.
		Flotation	Suspended solids and non-aqueous phase liquids are attached to gas bubbles are floated to the surface of an aqueous solution, where they are skimmed.	Not applicable to known waste forms at the site.
		Filtration	Solids are removed from by running the aqueous solution through a filter medium (membrane or aggregate).	Not applicable to known waste forms at the site.
		Adsorption	Liquid or gas is passed over adsorption media (i.e. activated carbon), to which contaminants are attached.	Not applicable to known waste forms at the site.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
REMEDIAL TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
		Membrane Processes	A waste stream is forced through a membrane which selectively allows some components to pass while retaining others (reverse osmosis).	Not applicable to known waste forms at the site.
		Freeze Crystallization	Dissolved solids are removed from solution by freezing.	Not applicable to known waste forms at the site.
		Air Stripping	Air is forced through liquid, or liquids are cascaded through a tower with air flowing in the opposite direction, to transfer volatile components from the liquid to air.	Not applicable to known waste forms at the site.
		Steam Stripping	The same as air stripping, except that the media are heated to enhance the transfer from of volatile from solution to the gaseous phase.	Not applicable to known waste forms at the site.
		Evaporation	Water is evaporated, leaving non-volatile contaminants in a concentrated solution. Evaporated water can be collected and condensed.	Not applicable to known waste forms at the site.
		Distillation	Contaminated solution is heated to volatilize specific organic contaminants. Vapor-phase is collected and condensed for the recovery or further treatment of the organics.	Not applicable to known waste forms at the site.
		Liquid-Liquid Extraction	Contaminants are transferred from one liquid to a second, immiscible liquid by mixing or countercurrent flow. Similar to air stripping.	Not applicable to known waste forms at the site.
		Critical Fluid Extraction	Contaminants from a waste stream are transferred to a gas at critical conditions; when the gas returns to atmospheric conditions, the contaminants are separated from it.	Not applicable to known waste forms at the site.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
REMEDIAL TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
	Chemical Treatment	Neutralization	Reagents added to waste stream to adjust pH to neutrality.	Not applicable to known waste forms at the site.
		Precipitation	Reagents that effect thermodynamic equilibria of contaminants are added to a solution, resulting in the precipitation of dissolved contaminants.	Not applicable to known waste forms at the site.
		Ion Exchange	Contaminant ions are exchanged with those of an ion exchange resin, replacing them in solution with non-hazardous constituents.	Not applicable to known waste forms at the site.
		Oxidation	Oxidizing agents added to solution to oxidize inorganics and some organics to less toxic oxidation state or destroy some organics.	Not applicable to known waste forms at the site.
		Reduction	Reducing agents added to solution to reduce some inorganics to less toxic or soluble oxidation states.	Not applicable to known waste forms at the site.
		Organic Chemical Dechlorination	Reagents added to solution to remove chlorine ions from chlorinated hydrocarbons.	Experimental process option, not proven effective. Not applicable to known waste forms at the site.
		Irradiation	Waste stream is subjected to radiation to promote chemical, physical, and/or biological changes, resulting in the reduction in toxicity or destruction of hazardous constituents.	Not applicable to known waste forms at the site.
	Biological Treatment	Aerobic Processes	Organic wastes degraded and/or mineralized by a mixed culture of microorganisms in aerobic conditions. Inorganics oxidized and sequestered to waste fraction (sludge).	Not applicable to known waste forms at the site.
		Anaerobic Processes	Organic wastes degraded and/or mineralized by a mixed culture of microorganisms in anaerobic conditions.	Not applicable to known waste forms at the site.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
REMEDIAL TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
		Facultative Processes	Organics and inorganics removed from waste stream through use of a mixed culture of facultative microorganisms in aerobic and anaerobic conditions.	Not applicable to known waste forms at the site.
		Land Treatment	Waste water and/or sludges are applied to open land. Organics are biodegraded; nutrients and metals are consumed by vegetation or are adsorbed to soils.	Not applicable to known waste forms at the site.
		Wetlands Treatment	Metals are removed by biological and chemical/physical processes in the facultative conditions of a wetland.	Not applicable to known waste forms at the site.
		Publicly-Owned Treatment Works	Contaminated water is combined with municipal sewage and treated at the POTW. In this case, POTW employs aerobic activated sludge followed by anaerobic digestion of sludge. VOCs removed during aerobic process; metals sequestered to sludge fraction.	Not applicable to known waste forms at the site.
	Thermal Treatment	Incineration	Hazardous materials thermally destroyed by incineration at high temperatures.	Not applicable to known waste forms at the site.
		Co-Disposal Processes	Waste materials mixed with other materials and used as a supplemental fuel source.	Not applicable to liquid or gaseous phase wastes.
		Pyrolysis	Hazardous materials destroyed in an oxygen deficient atmosphere.	Not applicable to liquid or gaseous phase wastes.
		Wet Air Oxidation	Waste is mixed with air and hazardous constituents are destroyed at high temperatures and pressures.	Not applicable to known waste forms at the site.
	In Situ Treatment	Air Sparging	Air is injected into groundwater to promote in situ volatilization of organic contaminants.	Not applicable to known waste forms at the site.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
REMEDIAL TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
		Soil Vapor Extraction	Passive and/or active soil vents are installed to intercept soil vapors and vent them to the atmosphere.	Not applicable to known waste forms at the site.
		Bioremediation	Microbiological degradation of hazardous substances in groundwater. Conditions are enhanced by adding amendments to groundwater to promote biological activity, thus increasing the rate of degradation.	Not applicable to known waste forms at the site.
		Landfill Gas Extraction	Passive and/or active soil vents are installed in and around a landfill to intercept landfill gas and vent it to the atmosphere, preventing groundwater contamination.	Not applicable to known waste forms at the site.
MONITORING	Monitoring	Monitoring	Monitoring of site conditions implemented to record and track site conditions and contamination levels.	Potentially effective if there is currently no risk to human health and the environment but there is potential for future risk if contaminants migrate. Also potentially effective in conjunction with other corrective measures. Readily implementable.

Legend

▨ - Technologies/Process options that are screened out.

6.1.4 Removal

Removal involves extracting waste materials from the site to be treated and/or disposed elsewhere. Removal technologies include excavation of solid materials, pumping or bailing of liquids; removal of contaminated groundwater by wells or collection trenches; or extraction of contaminated soil vapors or landfill gases. Since there are no known gaseous-phase waste forms present, and there is no known exceedence of groundwater protection standards beyond the point of compliance, these removal options have been screened from further consideration at this time. These options may be reconsidered if further site characterization determines that landfill gas or groundwater contamination are greater problems than indicated by existing data.

6.1.5 Solids Treatment

This general response action involves treating or processing solid-phase waste materials to reduce their volume and/or toxicity. Solids can be treated in situ or after removal. The treated solids can be disposed (on- or off-site) or used in some beneficial manner. Solids can be treated by physical/chemical, thermal, or biological methods. Solids treatment is not implementable at this site due to the volume of wastes present. Therefore, solids treatment options were not included in the reclamation alternatives.

6.1.6 Non-Solids Treatment

Non-solids treatment addresses liquid or gaseous-phase waste materials. The materials are processed or treated to reduce their volume and/or toxicity. Treatment methods include physical methods (such as liquids separation, adsorption, or air stripping); chemical methods (such as neutralization/precipitation); thermal treatment (such as incineration); and biological treatment (such as aerobic oxidation or anaerobic digestion). While most of these technologies require removal of the non-solid media, some can be completed in situ.

Non-aqueous phase liquid or gaseous-phase wastes are not known to exist at the site. Also, groundwater protection standards have not been exceeded beyond the point of compliance. Therefore, non-solids treatment technologies have been screened from further consideration at this time.

6.1.7 Monitoring

Monitoring involves the continued observation and tracking of waste materials at a site. While it does not reduce the volume or toxicity of waste materials, it monitors their setting and ongoing status. In this way, monitoring may be useful if there is no current threat posed by the waste materials, but there is concern that there may be a potential threat in the future. Also, monitoring may be used in conjunction with other general response actions to ascertain their effectiveness.

6.2 DEVELOPMENT AND EVALUATION OF CORRECTIVE MEASURES ALTERNATIVES

Retained technologies and process options are assembled and developed as reclamation alternatives below. These alternatives do not contain all technologies and process options listed in Table 6-2, but they are considered representative of the remaining process options available. The reclamation alternatives are identified in Table 6-3.

TABLE 6-3
RECLAMATION ALTERNATIVES FOR THE OLD BUTTE LANDFILL/CLARK TAILINGS SITE

ALTERNATIVE 1:	NO ACTION
ALTERNATIVE 2:	INSTITUTIONAL CONTROLS
ALTERNATIVE 3:	NATIVE MATERIALS CAPPING
ALTERNATIVE 4:	NATIVE MATERIALS CAPPING WITH INSTITUTIONAL CONTROLS
ALTERNATIVE 5:	MULTIMEDIA CAPPING WITH INSTITUTIONAL CONTROLS

The alternatives are developed and described, and then they are subjected to a preliminary screening based on effectiveness, implementability, and cost. The purpose of this screening is to identify those alternatives appropriate to be retained for subsequent, detailed analysis. The initial screening also helps identify technology-specific data needs for detailed site characterization as well as needs for possible treatability studies.

The evaluation of effectiveness includes determining the ability of an alternative to process the contaminated media sufficiently to achieve the remediation goals and to provide for overall protection of human health and the environment. The effectiveness screening criteria includes consideration of the nature and extent of the contamination, as well as site-specific conditions, such as geology, hydrology, hydrogeology, climate, and land use. The effectiveness of containment alternatives to prevent the generation of leachate and potential groundwater degradation has been assessed using the Hydrologic Evaluation of Landfill Performance (HELP) model (EPA, 1994b).

The implementability of each alternative has been evaluated to consider the technical and administrative feasibility of constructing, operating, and maintaining the reclamation alternative.

Technical feasibility considerations include applicability of the alternative to the waste source(s), availability of the required equipment and expertise to execute the alternative, and overall reliability of the alternative. Administrative feasibility considerations include logistical and scheduling constraints. The evaluation of implementability also considers appropriate combinations of alternatives with respect to site-specific conditions.

Cost screening consists of developing order-of-magnitude cost estimates for each remedial alternative based on similar sets of assumptions. Costs have been developed using the EPA Cost of Remedial Alternatives (CORA) Model, Version 3.0, and by analyzing data available from screening and implementing remedial alternatives at similar sites. Unit and total costs presented in the cost evaluations are present worth values structured to account for contaminated materials handling, adverse site conditions, administrative and engineering costs, and contingency. Total costs were derived by applying estimated unit costs to assumed volumes of contaminated solid media. Present worth value for operation and maintenance costs were determined for a 30-year project life at a 10% discount value.

A screening summary is presented after evaluating each alternative to identify alternatives retained for further consideration (detailed evaluation/analysis) and to offer a rationale for excluding those alternatives that will not be considered further.

6.2.1 Alternative 1 - No Action

The NCP requires the consideration of a no action alternative as a basis for consideration of other alternatives. The no action alternative means that no actual reclamation activities will occur at the site to control contaminant migration or to reduce toxicity or volume. The site would persist as is, with the Old Landfill only partially capped, the Clark Tailings cap partially eroding, and on-site groundwater contamination unaddressed.

Effectiveness - Protection of human health and the environment would not be achieved under the no action alternative. Prevention of direct human contact to wastes would not be achieved. The potential for solid media contaminant sources present at the to site contribute to surface water contamination would exist. Also, potential development of the aquifer for potable water use exists, which may result in the exposure to humans of the groundwater CoC via ingestion. Toxicity, mobility, and volume of contaminants would not be reduced under the no action alternative. Also, this alternative is not effective at satisfying state requirements for landfill closure, as required by the landfill's operating license issued by MDHES.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Screening Summary

This alternative has been retained as a comparison to other alternatives as suggested by the NCP.

6.2.2 Alternative 2 - Institutional Controls

The institutional control alternative includes erecting fences to restrict access to site, land use restrictions to control land development on or near the affected areas, and groundwater use restrictions to control the development and use of the affected aquifer in an unsafe manner.

New fence, consisting of a 10-ft high chain-link fence, would be constructed around the perimeter of the site to restrict access. In addition, deed restrictions would be instituted that would not allow for the development of the site in a manner that may lead to increased exposure to the waste materials. The landfill site is currently owned by BSB. The adjacent Clark Tailings are owned by Inland Properties. BSB and Inland Properties are currently negotiating the transfer of the Clark Tailings property to BSB. Under this transfer, the deeds would include restrictive covenants as necessary.

A controlled groundwater use area would be established through local ordinance and the DNRC. Also, permitting or approval from the Butte-Silver Bow Water Quality District (currently being formed) may be performed. The boundaries of the controlled use zone would be established by the BSB Water Quality District based on the extent of groundwater contamination. Within the zone, groundwater could not be used as a potable water supply. As discussed in Section 5.3, that groundwater contamination has not caused the exceedence of groundwater protection standards in wells downgradient from the site, and there are currently no known potable water supply wells downgradient of the site. Monitoring would be conducted to track the extent and fate of groundwater contamination.

Effectiveness - This alternative will not satisfy regulations pertaining to landfill closure. It will minimize threats to human health by restricting access to the site and preventing the use of the affected aquifer as a potable water supply. Also, it would minimize exposure by direct contact with the source materials (Clark Tailings and municipal solid waste) by restricting access to the site. However, the potential for migration of groundwater CoC would remain.

Implementability - Access restrictions to the site (fencing) are technically and administratively feasible and implementable. Access restrictions would contradict the community's plans for developing the site as a recreational facility, however. Deed restrictions are also easily implementable, particularly once the Clark Tailings property is transferred to BSB. Establishment of the controlled groundwater use area is implementable, but may require the agreement of affected aquifer users (who hold water rights) and public acceptance.

Cost Screening - Costs associated with institutional controls, shown on Table 6-4, would be relatively low as compared to other remedial measures. Capital costs are estimated at

TABLE 6-4

PRELIMINARY COST ESTIMATE - ALTERNATIVE 2
INSTITUTIONAL CONTROLS

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
CAPITAL COSTS					
Mobilization	1	L.S.	1000	1000	Estimate
Construct Chain Link Fence	10000	L.F.	10	100000	Continental Fence
Institute Land Use Restrictions	1	L.S.	5000	5000	Estimate
Institute Controlled Groundwater Use Zone	1	L.S.	50000	50000	Estimate
Subtotal				156000	
Engineering / Oversight (10%)				15600	
Subtotal Capital Costs				171600	
Contingency (10%)				17160	
TOTAL CAPITAL COSTS				**$188,760**	

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	2	/Year	500	1000	Estimate
Groundwater Monitoring - Sampling and Analysis	16	/Year	2000	32000	Experience
Maintenance	1	L.S.	1000	1000	Estimate
Subtotal				34000	
Contingency (10%)				3400	
ANNUAL 30 YEAR O&M COST				**$37,400**	

TABLE 6-4 Continued

TOTAL CAPITAL COSTS	188760
PRESENT WORTH, POST-CLOSURE MAINTENANCE AND MONITORING (10%)	352308
TOTAL PRESENT WORTH COST	**$541,068**

$188,760, with operation and maintenance (O&M) costs estimated at $37,400 annually. The total present worth, based on a 30-year life, is $541,000.

Screening Summary

Institutional controls will not be considered further as a stand-alone remedial alternative but may be used in conjunction with other selected treatment alternatives.

6.2.3 Alternative 3 - Native Materials Capping

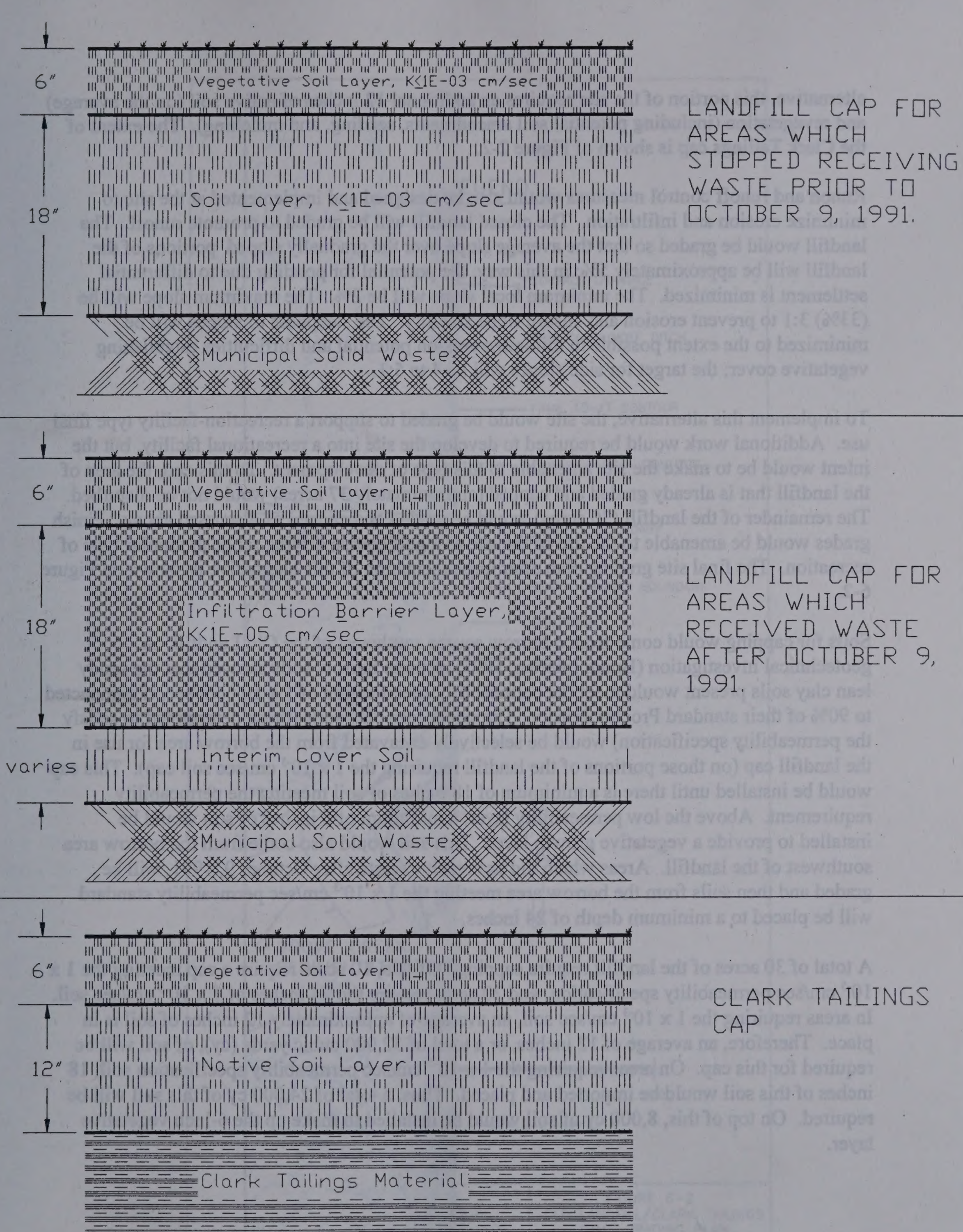
This alternative would include the installation of a cap comprised of native materials. The cap would be designed to satisfy landfill closure requirements. The Clark Tailings portion of the cap would be designed to support native vegetation. Typical cap cross-sections are shown on Figure 6-1 and are described below.

For the landfill, the cap would consist of:

- installation of a minimum 24 inches cap with a maximum permeability of 1×10^{-3} cm/sec for areas which stopped receiving waste after October 9, 1991;
- installation of a minimum 18 inches cap with a maximum permeability of 1×10^{-5} cm/sec, overlain by a minimum 6 inches earthen material layer capable of sustaining native plant growth, for those areas which received waste after October 9, 1991;
- revegetation of the cap to minimize erosion; and
- runon and runoff control to prevent erosion and minimize infiltration.

The landfill covers approximately 67 acres. Of this, 37 acres have been graded and capped in accordance with the guidelines stated above. Of the remaining 30 acres, approximately 20 acres will require 24 inches of the 1×10^{-3} cm/sec soil cap and 10 acres will require 18 inches of the low permeability and 6 inches of the erosion control layer cap. In areas requiring 24 inches of the 1×10^{-3} cm/sec soil cap, an average of approximately 12 inches of soil is in place (based on an existing cover investigation performed by SRM in 1992). Therefore, and additional 12 inches of soil meeting the permeability specification will be required. The entire area may require nutrient addition and seeding to establish a vegetative cover. A site plan showing the areas already capped and those requiring additional capping are shown on Figure 2-2.

On the Clark Tailings, the cap would consist of a minimum 18 inches soil cap. This cap would be graded and revegetated to minimize erosion. The Clark Tailings covers approximately 60 acres. This area was capped in the mid-1980's and revegetated. However, a full 18-inch cap was not installed. As a result, there are localized areas where gullies and rills have been observed. Also, there are portions of the site which have sparse vegetation. It is estimated that the average cap depth in place on the Clark Tailings is approximately 6 inches. Therefore, to complete this


6"
Vegetative Soil Layer, K≤1E-03 cm/sec
18"
Soil Layer, K≤1E-03 cm/sec
Municipal Solid Waste
LANDFILL CAP FOR AREAS WHICH STOPPED RECEIVING WASTE PRIOR TO OCTOBER 9, 1991.
6"
Vegetative Soil Layer
18"
Infiltration Barrier Layer, K<1E-05 cm/sec
varies
Interim Cover Soil
Municipal Solid Waste
LANDFILL CAP FOR AREAS WHICH RECEIVED WASTE AFTER OCTOBER 9, 1991.
6"
Vegetative Soil Layer
12"
Native Soil Layer
Clark Tailings Material
CLARK TAILINGS CAP

PIONEER
TECHNICAL SERVICES, INC.

FIGURE 6–1
NATIVE MATERIALS CAP
CROSS SECTIONS

DRAWING NO.: 9503004 REV: A
DATE: 04/26/95

alternative, this portion of the site requires an additional 12 inches of native soil (on the average) and revegetation (including potential soil amendments, seeding, and mulching). The extent of the Clark Tailings cap is shown of Figure 2-2.

Runon and runoff control measures would also be designed and implemented at the site to minimize erosion and infiltration. The closed landfill will be graded to promote runoff. The landfill would be graded so that the average slope over the gradually sloped portions of the landfill will be approximately 5%; in this way, the potential for ponding due to differential settlement is minimized. The minimum local slope will be 2%. The maximum slope will be (33%) 3:1 to prevent erosion and ensure slope stability. The steepness of slopes will be minimized to the extent possible to minimize erosion potential and difficulties establishing vegetative cover; the target for side slopes will be 4 to 5:1.

To implement this alternative, the site would be graded to support a recreation-facility type final use. Additional work would be required to develop the site into a recreational facility, but the intent would be to make the site amenable to this type of development. To this end, the area of the landfill that is already graded and capped (approximately 37 acres) would not be disturbed. The remainder of the landfill (30 acres) would be graded and capped as discussed above. Finish grades would be amenable to the use of the site as a golf course driving range or similar type of recreation. The final site grading plan after implementation of this alternative is shown on Figure 6-2.

Soils for capping would come from a borrow source southwest of the Old Landfill. A geotechnical investigation (Braun Intertec, 1993) of these borrow soils showed that the sandy lean clay soils present would meet the permeability specification of 1 x 10^{-5} cm/sec, if compacted to 90% of their standard Proctor density. The sandy lean clay soils (those determined to satisfy the permeability specification) would be selectively excavated from the borrow area for use in the landfill cap (on those portions of the landfill requiring the 1 x 10^{-5} cm/sec soil cap). This cap would be installed until there is a minimum of 18 inches of soil meeting the permeability requirement. Above the low permeability layer, a minimum of 6 inches of soil would be installed to provide a vegetative growth layer. This soil would also come from the borrow area southwest of the landfill. Areas which did not receive waste after October 9, 1991, will be graded and then soils from the borrow area meeting the 1 x 10^{-3} cm/sec permeability standard will be placed to a minimum depth of 24 inches.

A total of 30 acres of the landfill require capping. Of this, 10 acres require a cap meeting the 1 x 10^{-5} cm/sec permeability specification, and 20 acres require the 24 inches of 1 x 10^{-3} cm/sec soil. In areas requiring the 1 x 10^{-3} cm/sec soil, an average of approximately 12 inches of soil is in place. Therefore, an average of 12 inches, or a total of 32,000 cubic yards (cy), of soil will be required for this cap. On areas requiring the 1 x 10^{-5} cm/sec permeability specification soil, 18 inches of this soil would be imported and placed. Thus, a total of 24,000 cy of this soil will be required. On top of this, 8,000 cy of soil would be installed to make up the 6-inch vegetative layer.

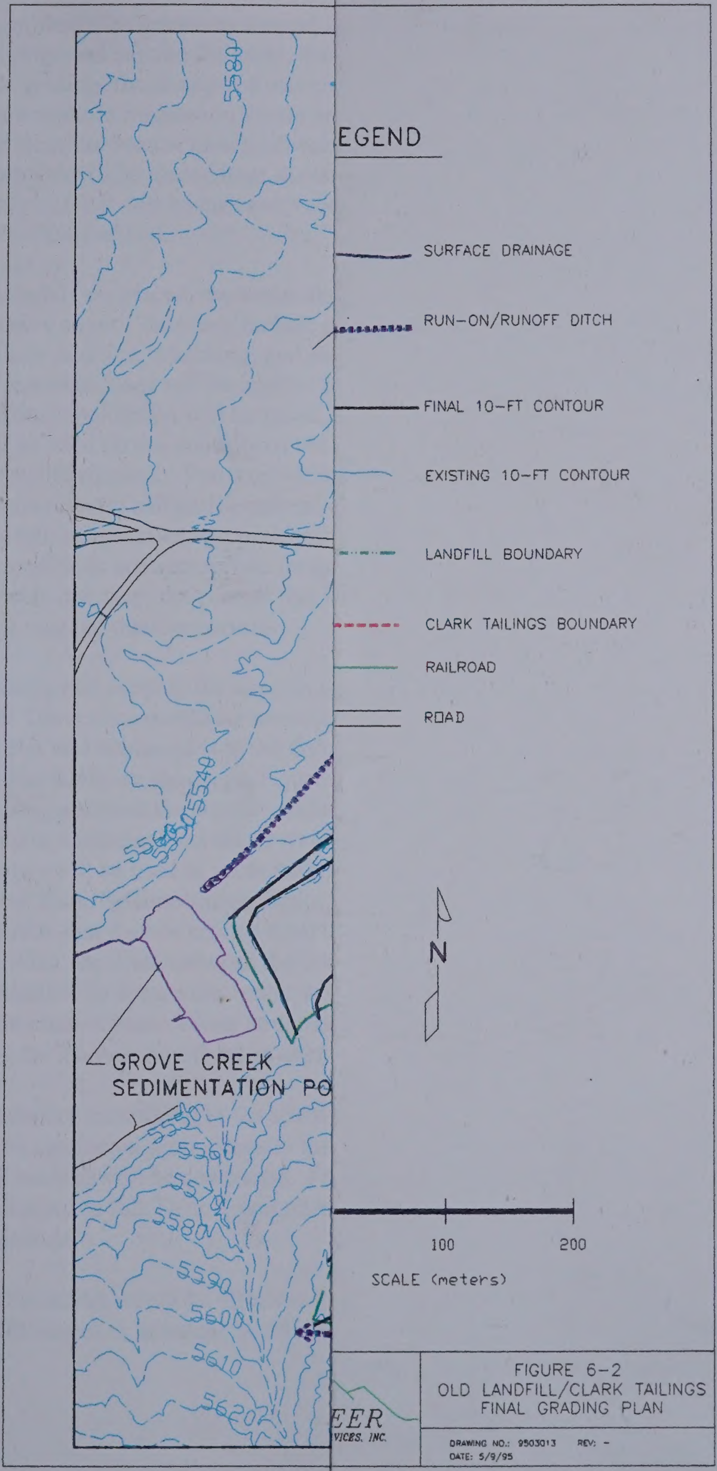

EGEND
SURFACE DRAINAGE
RUN-ON/RUNOFF DITCH
FINAL 10-FT CONTOUR
EXISTING 10-FT CONTOUR
LANDFILL BOUNDARY
CLARK TAILINGS BOUNDARY
RAILROAD
ROAD
N
100
200
SCALE (meters)
5580
5540
5550
5560
5570
5580
5590
5600
5610
5620
GROVE CREEK
SEDIMENTATION PO
EER
VICES, INC.
DRAWING NO.: 9503013 REV: –
DATE: 5/9/95

FIGURE 6–2
OLD LANDFILL/CLARK TAILINGS
FINAL GRADING PLAN

alternative, this portion of the site requires an additional 12 inches of native soil (on the average) and revegetation (including potential soil amendments, seeding, and mulching). The extent of the Clark Tailings cap is shown of Figure 2-2.

Runon and runoff control measures would also be designed and implemented at the site to minimize erosion and infiltration. The closed landfill will be graded to promote runoff. The landfill would be graded so that the average slope over the gradually sloped portions of the landfill will be approximately 5%; in this way, the potential for ponding due to differential settlement is minimized. The minimum local slope will be 2%. The maximum slope will be (33%) 3:1 to prevent erosion and ensure slope stability. The steepness of slopes will be minimized to the extent possible to minimize erosion potential and difficulties establishing vegetative cover; the target for side slopes will be 4 to 5:1.

To implement this alternative, the site would be graded to support a recreation-facility type final use. Additional work would be required to develop the site into a recreational facility, but the intent would be to make the site amenable to this type of development. To this end, the area of the landfill that is already graded and capped (approximately 37 acres) would not be disturbed. The remainder of the landfill (30 acres) would be graded and capped as discussed above. Finish grades would be amenable to the use of the site as a golf course driving range or similar type of recreation. The final site grading plan after implementation of this alternative is shown on Figure 6-2.

Soils for capping would come from a borrow source southwest of the Old Landfill. A geotechnical investigation (Braun Intertec, 1993) of these borrow soils showed that the sandy lean clay soils present would meet the permeability specification of 1×10^{-5} cm/sec, if compacted to 90% of their standard Proctor density. The sandy lean clay soils (those determined to satisfy the permeability specification) would be selectively excavated from the borrow area for use in the landfill cap (on those portions of the landfill requiring the 1×10^{-5} cm/sec soil cap). This cap would be installed until there is a minimum of 18 inches of soil meeting the permeability requirement. Above the low permeability layer, a minimum of 6 inches of soil would be installed to provide a vegetative growth layer. This soil would also come from the borrow area southwest of the landfill. Areas which did not receive waste after October 9, 1991, will be graded and then soils from the borrow area meeting the 1×10^{-3} cm/sec permeability standard will be placed to a minimum depth of 24 inches.

A total of 30 acres of the landfill require capping. Of this, 10 acres require a cap meeting the 1×10^{-5} cm/sec permeability specification, and 20 acres require the 24 inches of 1×10^{-3} cm/sec soil. In areas requiring the 1×10^{-3} cm/sec soil, an average of approximately 12 inches of soil is in place. Therefore, an average of 12 inches, or a total of 32,000 cubic yards (cy), of soil will be required for this cap. On areas requiring the 1×10^{-5} cm/sec permeability specification soil, 18 inches of this soil would be imported and placed. Thus, a total of 24,000 cy of this soil will be required. On top of this, 8,000 cy of soil would be installed to make up the 6-inch vegetative layer.

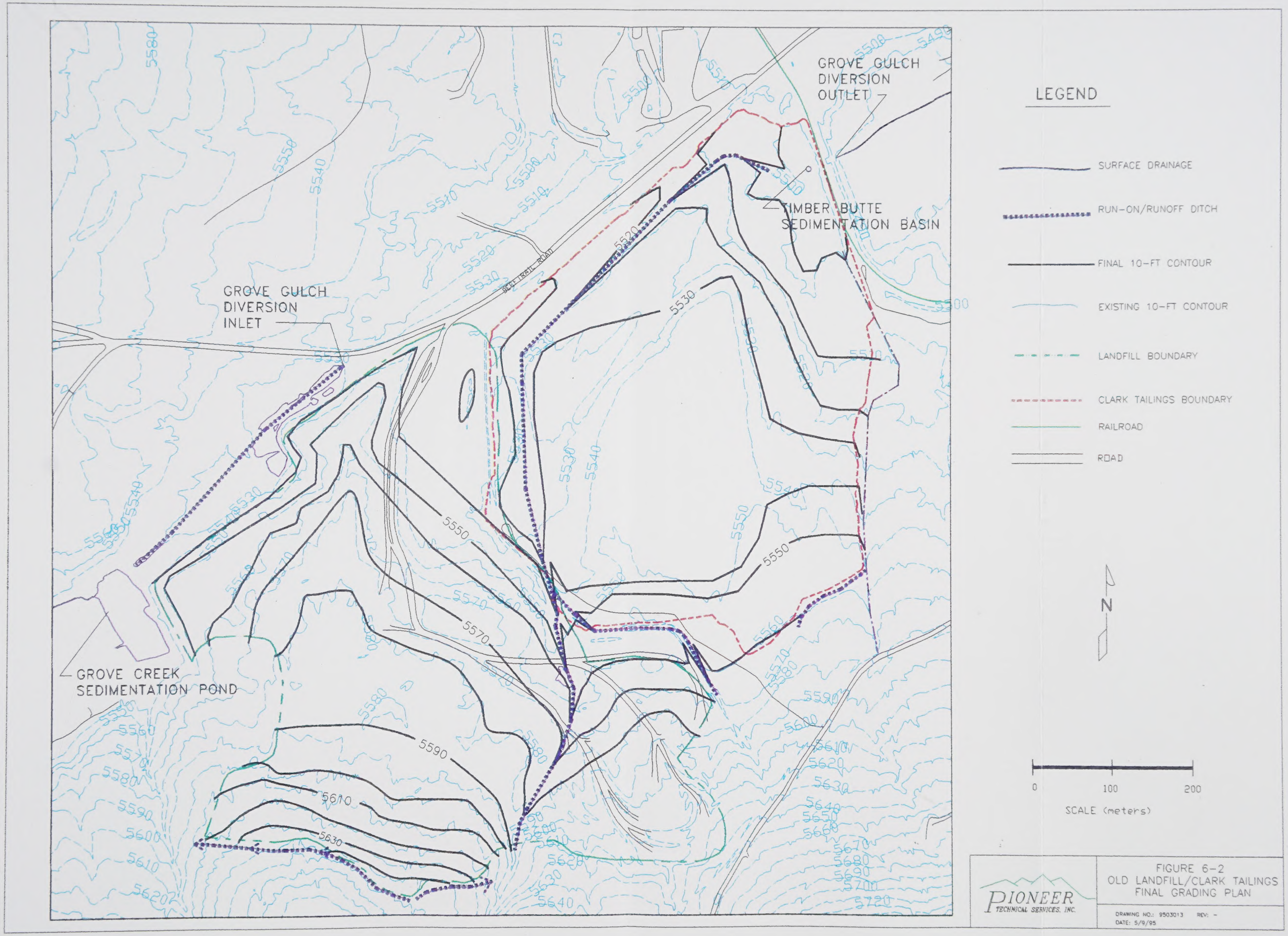

GROVE GULCH DIVERSION OUTLET
TIMBER BUTTE SEDIMENTATION BASIN
GROVE GULCH DIVERSION INLET
GROVE CREEK SEDIMENTATION POND
BEN TRAIL ROAD
5520
5530
5550
5570
5590
5610
5630
LEGEND
SURFACE DRAINAGE
RUN-ON/RUNOFF DITCH
FINAL 10-FT CONTOUR
EXISTING 10-FT CONTOUR
LANDFILL BOUNDARY
CLARK TAILINGS BOUNDARY
RAILROAD
ROAD
N
0
100
200
SCALE (meters)
PIONEER
TECHNICAL SERVICES, INC.

FIGURE 6-2
OLD LANDFILL/CLARK TAILINGS
FINAL GRADING PLAN

DRAWING NO.: 9503013 REV: -
DATE: 5/9/95

The Clark Tailings would be graded to support it's use for athletic fields, such as baseball and/or soccer fields. In proposed cut and fill areas, existing cap materials would be removed and stockpiled. After grading, the stockpiled material would be reinstalled as cap. In areas where existing grades are suitable, vegetation would be stripped. Additional capping materials would then be imported from the borrow area southwest of the landfill. In total, a minimum of 18 inches of soil material will be placed over the tailings. To attain this depth, an average of an additional 12 inches of soil will be necessary above the existing cap. This will require approximately 97,000 cy of soil.

After capping materials are placed, the entire site (approximately 127 acres) will be prepared to establish a vegetative cover. This may include organic material (in the form of stabilized sewage sludge) and fertilizer addition, mulching, and seeding. Stabilized sewage sludge from the Butte Metro Sewage Treatment Plant will be applied by BSB personnel using their sludge application equipment. Fertilizer application will be based on the nutrient requirements of the amended soil. Straw mulch will be used on the majority of the site; it will be crimped into the ground with standard agricultural equipment. The area will be drill seeded with a mixture of annuals (to establish a vegetative cover) and native perennial grasses. If capping is completed in the summer, the area will be amended and mulched at that time. Fertilization and seeding will be postponed until conditions are appropriate for grass seeding (in the fall or spring). If the entire cap is not installed in one year, the portion that is completed in any given year will be mulched and seeded in that year, as weather permits.

In addition to grading and capping the site, structures would be installed to handle surface water runon and runoff. Diversions would be constructed at the south end of the facility to route runon around the perimeter and discharge it to the Grove Creek Sedimentation Pond or the Timber Butte Sedimentation Basin, as shown on Figure 6-2. Local topography makes it infeasible to route all local drainage around the site. Therefore, one drainage will be routed over the landfill in a ditch designed to handle at least the 25-year storm event without causing significant erosion. Other on-site ditches will be used to route runon and runoff to the Grove Creek Sedimentation Pond or the Timber Butte Sedimentation Basin. Together, these structures will remove the majority of any solids that may be eroded from the site before discharging the runon/runoff water to Grove Gulch. Also, the ditch between the Grove Gulch Sedimentation Pond and the diversion inlet would be redefined to ensure that water will be removed from the landfill vicinity and not allowed to infiltrate into wastes. These structures would be designed to accommodate the peak flow from at least the 25-year runoff storm event.

Long-term groundwater monitoring at the site would also be implemented. Groundwater sampling would be conducted semi-annually for 30 years or as agreed to by MDHES. Once per year, full Table 2 analysis will be conducted. For the other annual sampling event, analytical methods will be limited to full Table 1 procedures and Table 2 methods that detected analytes during previous rounds.

Effectiveness - This action would be effective in that it will prevent direct exposure of tailings and landfill wastes to humans. It will decrease the mobility of waste materials present at the site. It will minimize erosion and potential impacts to surface waters. The installation of the soil caps described will lessen the amount of water infiltration and leachate generation. Based on preliminary HELP modeling results, infiltration and leachate generation rates from the landfill will be decreased 38%, from an estimated 37,000 gallons per acre per year under the existing conditions to approximately 23,000 gallons per year. (After capping, landfill areas capped with the pre October 9, 1991, cap could generate approximately 24,000 gallons per acre per year of leachate. Areas capped with the post October 9, 1991, cap could generate an average of 21,000 gallons per acre per year.) Leachate from the Clark Tailings could be reduced approximately 31%, from 29,000 gallons per acre per year under existing conditions. HELP model results are included in Appendix C.

This alternative would not directly address existing groundwater contamination present beneath the landfill. However, groundwater protection standards have not been exceeded at wells downgradient of the point of compliance. This alternative would decrease the amount of surface water infiltration through the waste. This may minimize further groundwater contamination. If further groundwater contamination is minimized, existing groundwater contamination may be adequately addressed through attenuation and natural degradation.

The possibility exists that the source of the groundwater contamination is not surface water infiltration. Local groundwater flow may rise and flow through the landfill at times, dissolving contaminants in the landfill and causing them to migrate with the groundwater. Also, the possibility exists that non-aqueous phase liquid (NAPL) plume of contaminants exists, potentially causing groundwater contamination. Landfill gas also may be a cause of groundwater contamination. There is no evidence at this time that any of these phenomena are contributing to groundwater contamination. Further site characterization designed to address these possibilities must be completed before the full effectiveness of this alternative can be determined.

Implementability - This alternative is technically feasible. The capping and surface water controls required are proven technologies. Borrow soils are locally available from BSB property southwest of the site. These soils, when compacted, will meet the permeability specifications for the landfill cap (Braun, 1993). The alternative could be implemented by BSB directly or it could be contracted. The alternative is also administratively feasible. The ability of the alternative to minimize the spread of groundwater contamination must be determined to determine if other actions, in addition to this, must be implemented to satisfy administrative requirements. Permitting requirements would be minimal.

Cost Screening - The total present worth cost for this alternative, based on a 30-year life, has been estimated at $1,413,000. Estimated costs are shown on Table 6-5. The total cost includes capital costs and the present worth value of 30 years of annual maintenance and groundwater monitoring.

TABLE 6-5

PRELIMINARY COST ESTIMATE - ALTERNATIVE 3
NATIVE MATERIALS CAPPING

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
CAPITAL COSTS					
Mobilization, Bonding, and Insurance	1	L.S.	30000	30000	Estimate
Construct Clark Tailings Cap	60	Acres	5000	300000	Engineering Estimate
Construct Pre-1991 Landfill Cap	20	Acres	5000	100000	Engineering Estimate
Construct Post-1991 Landfill Cap	10	Acres	9000	90000	Engineering Estimate
Organic Amendment	127	Acres	500	63500	Schaefer
Fertilize, Seed, and Mulch	127	Acres	1500	190500	Schaefer
Surface Water Diversions	4500	L.F.	8	36000	Vosburg EE/CA
Grove Gulch Channel Reconstruction	1000	L.F.	12	12000	Estimate
Subtotal				822000	
Engineering / Construction Oversight (15%)				123300	
Subtotal Capital Costs				945300	
Contingency (10%)				94530	
TOTAL CAPITAL COSTS				**$1,039,830**	

TABLE 6-5 Continued

POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	2	/Year	500	1000	Estimate
Groundwater Monitoring - Sampling and Analysis	16	/Year	2000	32000	Experience
Maintenance	1	L.S.	3000	3000	Estimate
Subtotal				36000	
Contingency (10%)				3600	
ANNUAL 30 YEAR O&M COST				**$39,600**	

TOTAL CAPITAL COSTS	1039830
PRESENT WORTH, POST-CLOSURE MAINTENANCE AND MONITORING (10%)	373032
TOTAL PRESENT WORTH COST	**$1,412,862**

Screening Summary

This alternative is considered effective. This alternative is readily implementable. It is required, at a minimum, to satisfy MDHES regulations for landfill closure. The alternative will be retained for further consideration.

6.2.4 Alternative 4 - Native Materials Capping with Institutional Controls

This alternative includes implementing institutional controls to prevent exposure in addition to installing a native materials cap as described in Section 6.2.3. Institutional controls may include:

- deed restrictions to prevent the development of the site in a manner inconsistent with the BSB Land Use Master Plan and ARM 16.14.530;
- implementing ordinances that would restrict the use of the affected aquifer;
- implementing a groundwater monitoring program to ensure that downgradient aquifer users are not exposed to CoC; and
- monitoring.

The area of the site is currently owned by BSB and Inland Properties. BSB is currently in the process of acquiring the Clark Tailings property from Inland Properties so that BSB will be the sole owner of the site. The area is currently zoned for recreational uses. Deed restrictions would also be implemented to prevent the development of the site in a manner that may not be protective of human health and the environment.

Institutional controls would be effective in preventing exposure of contaminants to humans by the development of the effected aquifer for use as a potable water supply. It should be noted that groundwater protection standards have not been exceeded in wells downgradient from the point of compliance (as discussed in Section 5.3).

A post-closure groundwater monitoring program would be implemented (as required under solid waste regulations at ARM 16.14.712). This monitoring program would include downgradient wells to ensure that the contamination plume is not impacting any downgradient potable water supply wells.

Effectiveness - This alternative may be effective in addressing groundwater contamination in the same manner as the native soil cap described in Section 6.2.3. Furthermore, by implementing institutional controls, the possibility of exposure to humans is further reduced. Deed and/or zoning restrictions would prevent development of the site in a manner which would be inconsistent with BSB's Land Use Master Plan and ARM 16.14.530. By implementing controls on the development and use of effected groundwater in the vicinity of the site, human exposure to groundwater contamination can be minimized.

By implementing a controlled groundwater use area, exposure to contaminants via ingestion of contaminated groundwater will be prevented. Post-closure monitoring of the groundwater will determine if the alternative is effective in addressing existing groundwater contamination.

Implementability - The capping portion of this alternative is technically and administratively feasible. Institutional controls are also feasible and implementable. Establishment of the controlled groundwater use area is implementable, but may require the agreement of affected aquifer users (who hold water rights) and public acceptance.

Cost Screening - The total present worth cost for this alternative has been estimated at $1,482,000. The majority of these costs are for installation of the native soils cap. Estimated costs are shown on Table 6-6. The total cost includes capital costs and the present worth value of 30 years of annual maintenance and groundwater monitoring.

Screening Summary

This alternative would protect human health by minimizing exposure to humans. It is considered to be more effective at preventing exposure than the native soils cap by itself (Alternative 3) since it would control the use and development of local groundwater, the primary exposure pathway of concern. Therefore, this alternative will be retained for detailed analysis.

6.2.5 Alternative 5 - Multimedia Capping

In this alternative, a multimedia cap would be placed over the Old Landfill and Clark Tailings to minimize infiltration of surface water through the wastes and the ensuing production of leachate. This alternative is very similar to the native soil cap alternative except that a multimedia cap would be installed instead of the native soil cap described in Section 6.2.3. The cap would consist of a vegetated soil/erosion control layer, a subsurface drainage layer, a flexible membrane liner, and a native clay or geosynthetic clay liner (GCL). A typical cross-section of the cap is shown on Figure 6-3.

For this preliminary evaluation, it is assumed that the multimedia cap would be placed over the entire site (127 acres). Runon/runoff controls to manage surface water would also be installed. Additional data, as explained in Section 8.0, must be gathered to conduct a detailed evaluation of this alternative.

In addition to installing a multimedia cap, institutional controls could be implemented to minimize the potential of exposure. These controls would be the same as those explained for the native soils cap with institutional controls alternative (Section 6.2.4).

To implement this alternative, the site would first be graded in anticipation of it's development as a recreational facility. Target slopes would be a minimum of 2% on top slopes, with an average of at least 4%, and 33% (3H:1V) on side slopes. Topsoil and vegetation would be cleared and

TABLE 6-6

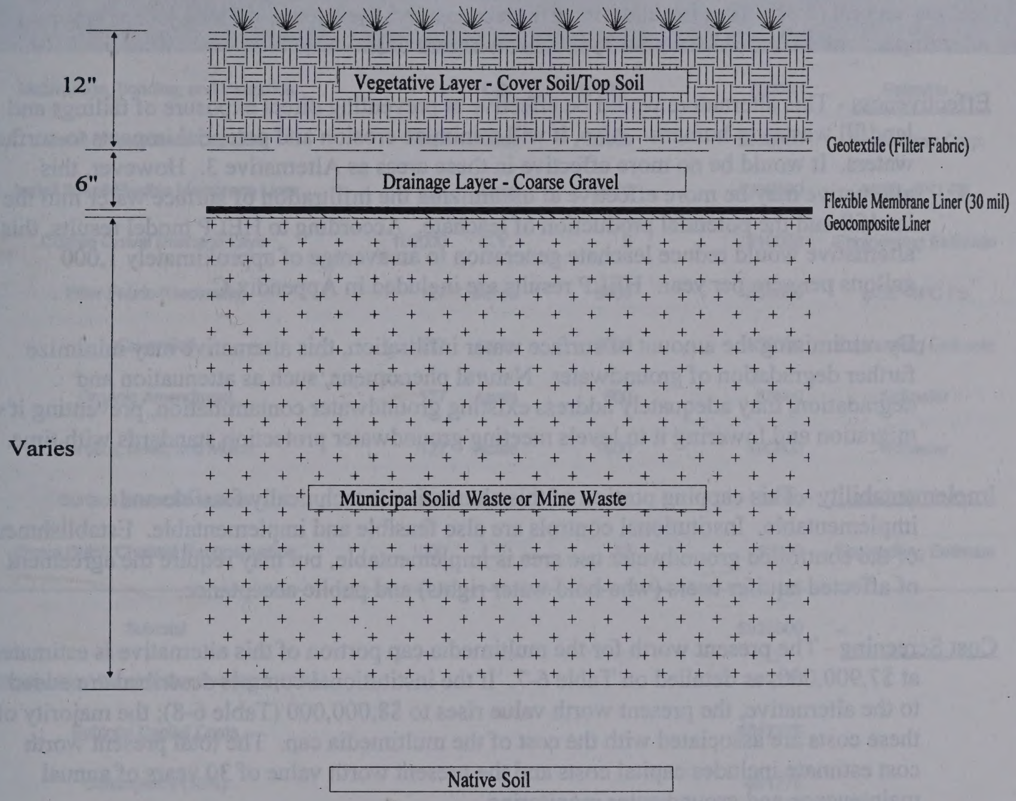
PRELIMINARY COST ESTIMATE - ALTERNATIVE 4
NATIVE MATERIALS CAPPING WITH INSTITUTIONAL CONTROLS

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
CAPITAL COSTS					
Mobilization, Bonding, and Insurance	1	L.S.	30000	30000	Estimate
Construct Clark Tailings Cap	60	Acres	5000	300000	Engineering Estimate
Construct Pre-1991 Landfill Cap	20	Acres	5000	100000	Engineering Estimate
Construct Post-1991 Landfill Cap	10	Acres	9000	90000	Engineering Estimate
Organic Amendment	127	Acres	500	63500	Schaefer
Fertilize, Seed, and Mulch	127	Acres	1500	190500	Schaefer
Surface Water Diversions	4500	L.F.	8	36000	Vosburg EE/CA
Grove Gulch Channel Reconstruction	1000	L.F.	12	12000	Estimate
Institute Land Use Restrictions	1	L.S.	5000	5000	Estimate
Institute Controlled Groundwater Use Zone	1	L.S.	50000	50000	Estimate
Subtotal				877000	
Engineering / Construction Oversight (15%)				131550	
Subtotal Capital Costs				1008550	
Contingency (10%)				100855	
TOTAL CAPITAL COSTS				**$1,109,405**	

TABLE 6-6 Continued

POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	2	/Year	500	1000	Estimate
Groundwater Monitoring - Sampling and Analysis	16	/Year	2000	32000	Estimate
Maintenance	1	L.S.	3000	3000	Estimate
Subtotal				36000	
Contingency (10%)				3600	
ANNUAL 30 YEAR O&M COST				**$39,600**	

TOTAL CAPITAL COSTS	1109405
PRESENT WORTH, POST-CLOSURE MAINTENANCE AND MONITORING (10%)	373032
TOTAL PRESENT WORTH COST	**$1,482,437**


12"
Vegetative Layer - Cover Soil/Top Soil
Geotextile (Filter Fabric)
6"
Drainage Layer - Coarse Gravel
Flexible Membrane Liner (30 mil)
Geocomposite Liner
Varies
Municipal Solid Waste or Mine Waste
Native Soil

PIONEER TECHNICAL SERVICES, INC.

FIGURE 6-3
ALTERNATIVE 5 -- MULTIMEDIA CAP

DRAWING NO.: BORDERA REV: -
DATE: 04/07/95

stockpiled. A minimum of 12 inches of the leveling materials would be placed over the wastes. Existing cover soil would be used for this purpose to the extent possible. The multimedia cap would then be installed. The cover soil would be amended as necessary to support a vegetative cover (with lime, sewage sludge, and/or fertilizer), seeded, and mulched. As with the minimum allowable cap, erosion control mats would be used on slopes greater than 2:1, if present, and in surface water diversions where the calculated velocities during the design event are greater than 2 feet per second (fps). After installation of these measures, the site would look just as it would after implementation of Alternative 3, shown on Figure 6-2.

Effectiveness - This alternative would be effective at preventing direct exposure of tailings and landfill wastes to humans. Also, it will minimize erosion and potential impacts to surface waters. It would be no more effective in these areas as Alternative 3. However, this alternative may be more effective at minimizing the infiltration of surface water into the landfill and the potential production of leachate. According to HELP model results, this alternative would reduce leachate generation to an average of approximately 1,000 gallons per acre per year. HELP results are included in Appendix C.

By minimizing the amount of surface water infiltration, this alternative may minimize further degradation of groundwater. Natural phenomena, such as attenuation and degradation, may adequately address existing groundwater contamination, preventing it's migration and lowering it to levels meeting groundwater protection standards with time.

Implementability - This capping portion of this alternative is technically feasible and implementable. Institutional controls are also feasible and implementable. Establishment of the controlled groundwater use area is implementable, but may require the agreement of affected aquifer users (who hold water rights) and public acceptance.

Cost Screening - The present worth for the multimedia cap portion of this alternative is estimated at $7,900,000, as detailed on Table 6-7. If the institutional controls described are added to the alternative, the present worth value rises to $8,000,000 (Table 6-8); the majority of these costs are associated with the cost of the multimedia cap. The total present worth cost estimate includes capital costs and the present worth value of 30 years of annual maintenance and groundwater monitoring.

Screening Summary

This alternative offers increased reduction in the generation of leachate from surface water infiltration than the native soils cap, but at a much higher cost. The possibility exists that the source of the localized groundwater contamination is not surface water infiltration. Local groundwater flow may rise and flow through the landfill material at times, dissolving contaminants in the landfill and causing them to be detected in groundwater samples collected on the site. Also, the possibility exists that a NAPL plume of contaminants exists, contributing to groundwater contamination. Landfill gas also may be a cause of groundwater contamination. There is no evidence at this time that any of these phenomena are contributing to groundwater contamination.

TABLE 6-7

PRELIMINARY COST ESTIMATE - ALTERNATIVE 5A
MULTIMEDIA CAPPING

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
CAPITAL COSTS					
Mobilization, Bonding, and Insurance	1	L.S.	100000	100000	Estimate
Install Geosynthetic Cap Liner	127	Acres	20000	2540000	James Clem Corp.
Install 30-mil Flexible Membrane Liner	127	Acres	9500	1206500	MSE - IPC FS
Coarse Gravel Drainage Layer	102000	C.Y.	5	510000	Engineering Estimate
Filter Fabric (Geotextile)	127	Acres	5000	635000	MSE - IPC FS
Cover Soil	127	Acres	5000	635000	Engineering Estimate
Organic Amendment	127	Acres	500	63500	Schaefer
Fertilize, Seed, and Mulch	127	Acres	1500	190500	Schaefer
Surface Water Diversions	4500	L.F.	8	36000	Vosburg EE/CA
Grove Gulch Channel Reconstruction	1000	L.F.	12	12000	Engineering Estimate
Subtotal				5928500	
Engineering / Construction Oversight (15%)				889275	
Subtotal Capital Costs				6817775	
Contingency (10%)				681778	
TOTAL CAPITAL COSTS				**$7,499,553**	

TABLE 6-7 Continued

POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	2	/Year	500	1000	Estimate
Groundwater Monitoring - Sampling and Analysis	16	/Year	2000	32000	Estimate
Maintenance	1	L.S.	10000	10000	Estimate
Subtotal				43000	
Contingency (10%)				4300	
ANNUAL 30 YEAR O&M COST				**$47,300**	

TOTAL CAPITAL COSTS	7499553
PRESENT WORTH, POST-CLOSURE MAINTENANCE AND MONITORING (10%)	445566
TOTAL PRESENT WORTH COST	**$7,945,119**

TABLE 6-8

PRELIMINARY COST ESTIMATE - ALTERNATIVE 5B
MULTIMEDIA CAPPING WITH INSTITUTIONAL CONTROLS

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
CAPITAL COSTS					
Mobilization, Bonding, and Insurance	1	L.S.	100000	100000	Estimate
Install Geosynthetic Cap Liner	127	Acres	20000	2540000	James Clem Corp.
Install 20-mil Flexible Membrane Liner	127	Acres	9500	1206500	MSE - IPC FS
Coarse Gravel Drainage Layer	102000	C.Y.	5	510000	Engineering Estimate
Filter Fabric (Geotextile)	127	Acres	5000	635000	MSE - IPC FS
Cover Soil	127	Acres	5000	635000	Engineering Estimate
Organic Amendment	127	Acres	500	63500	Schaefer
Fertilize, Seed, and Mulch	127	Acres	1500	190500	Schaefer
Surface Water Diversions	4500	L.F.	8	36000	Vosburg EE/CA
Grove Gulch Channel Reconstruction	1000	L.F.	12	12000	Engineering Estimate
Institute Land Use Restrictions	1	L.S.	5000	5000	Estimate
Institute Controlled Groundwater Use Zone	1	L.S.	50000	50000	Estimate
Subtotal				5983500	
Engineering / Construction Oversight (15%)				897525	
Subtotal Capital Costs				6881025	
Contingency (10%)				688103	
TOTAL CAPITAL COSTS				**$7,569,128**	

TABLE 6-8 Continued

POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	2	/Year	500	1000	Estimate
Groundwater Monitoring - Sampling and Analysis	16	/Year	2000	32000	Estimate
Maintenance	1	L.S.	10000	10000	Estimate
Subtotal				43000	
Contingency (10%)				4300	
ANNUAL 30 YEAR O&M COST				**$47,300**	

TOTAL CAPITAL COSTS	7569128
PRESENT WORTH, POST-CLOSURE MAINTENANCE AND MONITORING (10%)	445566
TOTAL PRESENT WORTH COST	**$8,014,694**

If institutional controls are implemented in addition to the cap, in the same manner as described for Alternative 4, this alternative would be effective at preventing the exposure to CoC by controlling groundwater use and future development of the site.

Because of the substantially higher costs and the uncertainties concerning actual benefits derived from implementation of this alternative and the availability of materials, this alternative will not be retained for further consideration.

6.3 SUMMARY OF ALTERNATIVE SCREENING

Each of the alternatives is briefly described and compared in Table 6-9.

7.0 INTERIM MEASURES ANALYSIS

Before the selection and implementation of a preferred alternative, interim measures may be employed to fill data gaps to assist in the selection of a preferred alternative. Additionally, other measures that are common to all viable alternatives may be implemented.

Additional data are necessary to fully characterize the site, as explained in Section 8.0. Collection of these data should begin as soon as practicable, so that a preferred alternative can be selected and implemented. These measures include: continued monitoring of existing groundwater monitoring wells; monitoring the pieziometric surface to determine if wastes are in contact with groundwater; and monitoring for the presence of and migration of landfill gas, including determining if volatile organic compound vapors are present.

Native soils capping will be a portion of the final remedy. Therefore, installation of the native soils cap, designed to comply with landfill closure regulations, should be continued in the interim. As part of the capping, runon and runoff controls should be designed and installed, also. Before commencing work, the topographic survey should be updated and the final grading plan updated to reflect construction and demolition filling activities that are planned for the northern portion of the Old Landfill (as required by MDHES's approval of the construction and demolition disposal, Attachment 4).

Upon the transfer of the Clark Tailings property to BSB, restrictive covenants should be placed in the deeds of both the Old Landfill and Clark Tailings properties. These covenants will satisfy the requirements of ARM 16.14.530.

Interim measures may be instituted if further site characterization finds that there is an immediate threat to human health and the environment at the site. These interim measures would be designed to mitigate any potential impacts that are not known at this time.

TABLE 6-9: ALTERNATIVE SCREENING SUMMARY

ALTERNATIVE	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING SUMMARY
1. No Action	No additional action is taken at the site. Site would remain with landfill only partially capped and Clark Tailings cap partially eroding.	Protection of human health and the environment is not achieved. Not effective at satisfying landfill closure requirements.	Not applicable.	There is no cost associated with this alternative.	This alternative will be retained for comparison of other alternatives as suggested by the NCP.
2. Institutional Controls	A fence would be installed around the site to prevent access. Land and groundwater use restrictions would be implemented.	Not effective at satisfying landfill closure regulations. Effective at minimizing exposure to CoC.	Access restrictions implementable, but contradict with community's end use plans for the site.	Present worth value of $541,000, includes $189,000 in capital costs and $37,400 in annual O&M costs.	This alternative will not be considered further as a stand alone alternative.
3. Native Materials Capping	Native materials caps installed to satisfy landfill closure regulations. Run-on/runoff controls installed. Long-term groundwater monitoring.	Effective at satisfying landfill closure regulations and preventing direct contact. Decrease amount of surface water infiltration through wastes.	Technically and administratively feasible. Compatible with final use plans. Not known if alternative will adequately address existing groundwater contamination.	Present worth value of $1,413,000, includes $1,040,000 in capital costs and $40,00 in annual O&M costs.	Alternative is implementable and potentially effective; it will be retained for further consideration.
4. Native Materials Capping with Institutional Controls	Land and groundwater use restrictions implemented in addition to native materials cap described in Alternative 3.	Effective at satisfying landfill closure regulations and preventing exposure to CoC.	Technically implementable. Implementation of controlled groundwater use zone will require agreement of affected groundwater users.	Present worth value of $1,482,000 includes $1,109,000 in capital costs and $40,000 in annual O&M costs.	Alternative is effective and implementable; it will be retained for further consideration.
5. Multimedia capping	A multimedia cap, consisting of native soils, a geosynthetic clay liner, and a flexible membrane liner would be installed to minimize infiltration through wastes. Institutional controls may also be implemented to control groundwater use.	Effective at preventing contact with CoC and minimizing surface water infiltration. Not certain if alternative would be effective at addressing groundwater contamination.	Technically and administratively implementable.	Present worth value of $7,945,000 includes $7,500,000 in capital costs and $47,000 in annual O&M costs. Present worth rises to $8,015,000 if institutional controls are added.	Alternative is potentially effective and implementable. However, due to high cost and uncertain effectiveness, this alternative will not be retained for further analysis.

8.0 SITE CHARACTERIZATION TASKS

8.1 CONTINUED GROUNDWATER MONITORING

Additional sampling rounds (approximately four) are necessary to establish a statistically significant number of measurements with which to compare downgradient groundwater concentrations to groundwater protection standards. The analyses need to include all detected Table 1 constituents (metals and 8260 volatiles); additional 8270 organics data are not considered to be necessary. These additional rounds will include field measured carbonate and bicarbonate alkalinity, which are currently not performed.

8.2 ADDITIONAL GROUNDWATER MONITORING WELLS

Existing downgradient wells should be added to the groundwater monitoring program to characterize groundwater downgradient from the site. These wells would be sampled at the same time as the existing monitoring wells to determine the impacts on the aquifer downgradient of the site. If monitoring shows that these wells are not impacted, they can be removed from the groundwater monitoring program.

8.3 WASTE SOURCE CHARACTERIZATION

Additional source characterization is necessary for areas that lack adequate data. First, an assessment of the potential impacts of landfill gas on the groundwater contamination should be completed. The observed groundwater contamination at the landfill appears to be a small, relatively localized problem; this may indicate that only a small area or volume of waste, located near wells A3 and A2 (the most contaminated wells), may be involved. Although it is not usually possible to characterize landfill wastes, the suite of primary CoC are volatile organic solvents, and these compounds are amenable to investigation using landfill gas/soil gas analyses. Organic vapors are a component of landfill gas and are often a source of groundwater contamination at landfills (Kerfoot, 1994). A soil gas survey over the landfill can help determine if landfill gas migration is a potential problem at the site and whether the volatile organics are present in the gaseous phase, potentially leading to groundwater contamination. Also, whether the volatiles are highly localized or represent a more widespread problem may be determined. Landfill gas monitoring is required at the landfill as a stipulation of allowing the landfill to continue to receive construction and demolition debris (Attachment 4).

The second source characterization need is to determine whether the base of the landfill is below the water table, with landfill wastes actually contacting groundwater either all or part of the year. This can be determined by installing piezometers through the landfill materials and monitoring them throughout the year. The determination of the depth of the base of the landfill would have to be made during the installation of the piezometers.

The third characterization need is to determine whether NAPLs may be present, either floating on top of the groundwater (LNAPL) or sinking to the bottom of the alluvial aquifer at the bedrock contact (DNAPL). Several of the compounds detected during the landfill monitoring could exist as DNAPLs (chlorinated solvents). To better investigate whether they exist at the landfill (especially DNAPLs), during routine monitoring a separate bailer should be run all the way to the bottom of wells A2 and A3 to collect samples. Rather than just visually inspecting the bailer, this bottom water (+/- DNAPL) should be sent to the analytical lab for a separate analysis. If the results are significantly higher than the normal (purged, full water column) sample, a DNAPL is indicated (but not proven). Additionally, wells A3 and A4 have water levels that are usually above the screened section of the well which precludes detection of a LNAPL. A separate surface sample (as above, unpurged) from well A3 should be collected for analysis, if the water level is below the top of the screen (19.5 feet bgs).

8.4 DETERMINE DOWNGRADIENT GROUNDWATER USE

A domestic well inventory of existing downgradient wells is necessary to evaluate the effectiveness of any of the alternatives. Database searches (the MBMG Water Well Log Database) have identified most of the wells downgradient of the site; however, some wells known to exist did not appear on the database. A full inventory of downgradient wells should be compiled, including the use of each well.

8.5 DETERMINE COVER SOIL PROPERTIES

Physical soil properties of the proposed borrow soil, located southwest of the landfill, have been determined under previous investigations. The physical properties which have been investigated include soil texture, grain size, Atterburg limits, and hydraulic conductivity/permeability. Additional physical properties which need to be investigated include moisture/density relationships (Proctor, ASTM D698), which are necessary to provide specific compaction requirements for construction of the landfill cover using these soils.

Also, revegetation parameters should be investigated to determine potential soil amendments for the cover soil source. Recommended testing of revegetation parameters include: pH, fertilizer recommendation, organic carbon content, and electrical conductivity. These tests are necessary to determine the fertility of the soils and quantify soil amendment requirements and rates. Analytical methods are identified in the Clark Fork River (CFR) Laboratory Analytical Protocol (PTI, 1991a).

8.6 UPDATE TOPOGRAPHIC SURVEY

The latest available topographic survey information (shown on the figures in this report) is from a June 16, 1991, aerial survey. Since that time, additional fill and cover materials have been placed at the landfill. An updated topographic survey is necessary to update the final grading plan and determine cut/fill requirements to attain the desired final grades. The updated survey will also be used to determine to stormwater runon/runoff management plan.

9.0 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality of the data required to support remedial decisions. DQOs for the Old Landfill/Clark Tailings Site were developed using the process outlined in "Data Quality Objectives For Remedial Response Activities, Development Process" (EPA, 1987). The data quality objectives for essentially all laboratory analyses will be enforcement quality (E). Field measurements, such as pH, specific conductance, etc., will be screening quality (S) data.

10.0 DATA MANAGEMENT PLAN

The CFR Data Management/Data Validation Plan (PTI, 1991b) specifies how data will be validated and managed for this site, with one exception. The data will not be placed within the Clark Fork Data Management System (CFDMS). Instead, the data for the site will be managed in spreadsheets and reported via paper copy.

11.0 PROCEDURES FOR THE DETAILED ANALYSIS OF RECLAMATION ALTERNATIVES

Inadequate data are available to allow for completion of the detailed analysis of alternatives and selection of a preferred alternative at this time. Before a detailed analysis can be conducted, additional data must be collected, as described in Section 8. The procedure that will be employed for the detailed analysis of alternatives is described below.

The MDHES Solid Waste Regulations [ARM 16.14.708(6)] contain criteria which must be considered during the analysis and selection of remedial actions. The reclamation alternatives retained following the screening process (presented in Section 6.0) will be evaluated individually against the following criteria, in accordance with ARM 16.14.708(6):

- effectiveness;
- time required to begin and complete the remedy;
- cost; and
- institutional requirements.

Effectiveness

Effectiveness is evaluated based on the performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination.

Timeliness

Timeliness is evaluated based on the time required to begin and complete the remedy.

Cost

Cost is evaluated based on the costs (both capital and ongoing operations) to implement the remedy.

Institutional Requirements

Institutional requirements are evaluated based on the ability to obtain necessary local or state permits or other environmental or public health requirements which may substantially affect implementation of the remedy.

The final step of the feasibility analysis is to conduct a comparative analysis of the alternatives. The analysis will include a discussion of the alternative's relative strengths and weaknesses with respect to each of the criteria and how reasonable key uncertainties could change expectations of their relative performance.

Once completed, this evaluation will be used to select the preferred alternative. The selection will be based on this evaluation and the following factors [in accordance with ARM 16.14.708(7)(b)]:

- magnitude of reduction of existing risks;
- magnitude of residual risks in terms of likelihood of further releases due to waste remaining following implementation of the remedy;
- the type and degree of long-term management required, including monitoring, operation, and maintenance;
- short-term risks that might be posed to the community, workers, or the environment during implementation of such a remedy, including potential threats to human health and environment associated with excavation, transportation, and redisposal or containment;
- time until full protection is achieved;
- potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, redisposal, or containment;
- long-term reliability of the engineering and institutional controls; and
- potential need for replacement of the remedy.

Selection of the remedy based on this procedure will be consistent with the NCP.

12.0 PROJECT SCHEDULE

The anticipated project schedule includes completing additional characterization tasks during the summer of 1995. Also, interim measures may be implemented in 1995. After completion of the site characterization tasks, a final corrective measures assessment, identifying a preferred alternative, will be completed. Following receipt and discussion of BSB comments, a public meeting, along with a public comment period, will be held to obtain public input on the proposed project. A remedy will be selected and designed during the winter of 1995/1996. Implementation of the selected remedy will begin in the spring of 1996. The project schedule is shown on Figure 12-1.

13.0 DELIVERABLES

Project deliverables documents that must be prepared to successfully complete the corrective measures process are listed below. Project deliverables can be considered milestones that must be met to maintain the project schedule. Project deliverables include:

- FINAL CORRECTIVE MEASURES ASSESSMENT;
- DETAILED FINAL ALTERNATIVES ANALYSIS AND PREFERRED ALTERNATIVE SELECTION REPORT;
- RESPONSE TO PUBLIC COMMENTS AND FINAL REMEDY SELECTION REPORT;
- CORRECTIVE MEASURES DESIGN PACKAGE;
- CONSTRUCTION QUALITY ASSURANCE REPORT; and
- AS-BUILT DRAWINGS.

14.0 PROJECT MANAGEMENT PLAN

The MDHES Solid Waste Program serves as the lead agency for this project. BSB is responsible for the performance of the work as outlined within this CMA through construction of the selected remedial alternative and post-construction monitoring.

15.0 COMMUNITY RELATIONS PLAN

ARM 16.14.708(6)(d) requires that the results of this assessment must be discussed with interested and affected parties at a public meeting before a remedy is selected. Therefore, once additional site characterization tasks and the detailed analysis of alternatives are completed, and a preferred alternative is identified, a public meeting will be held. The notice of public meeting will be published in the local newspaper. After the public meeting, the public will have period to provide comments on the preferred alternative. After receiving public comments, a remedy will be selected that considers public input. Public comments will be addressed in the Final Remedy Selection Report.

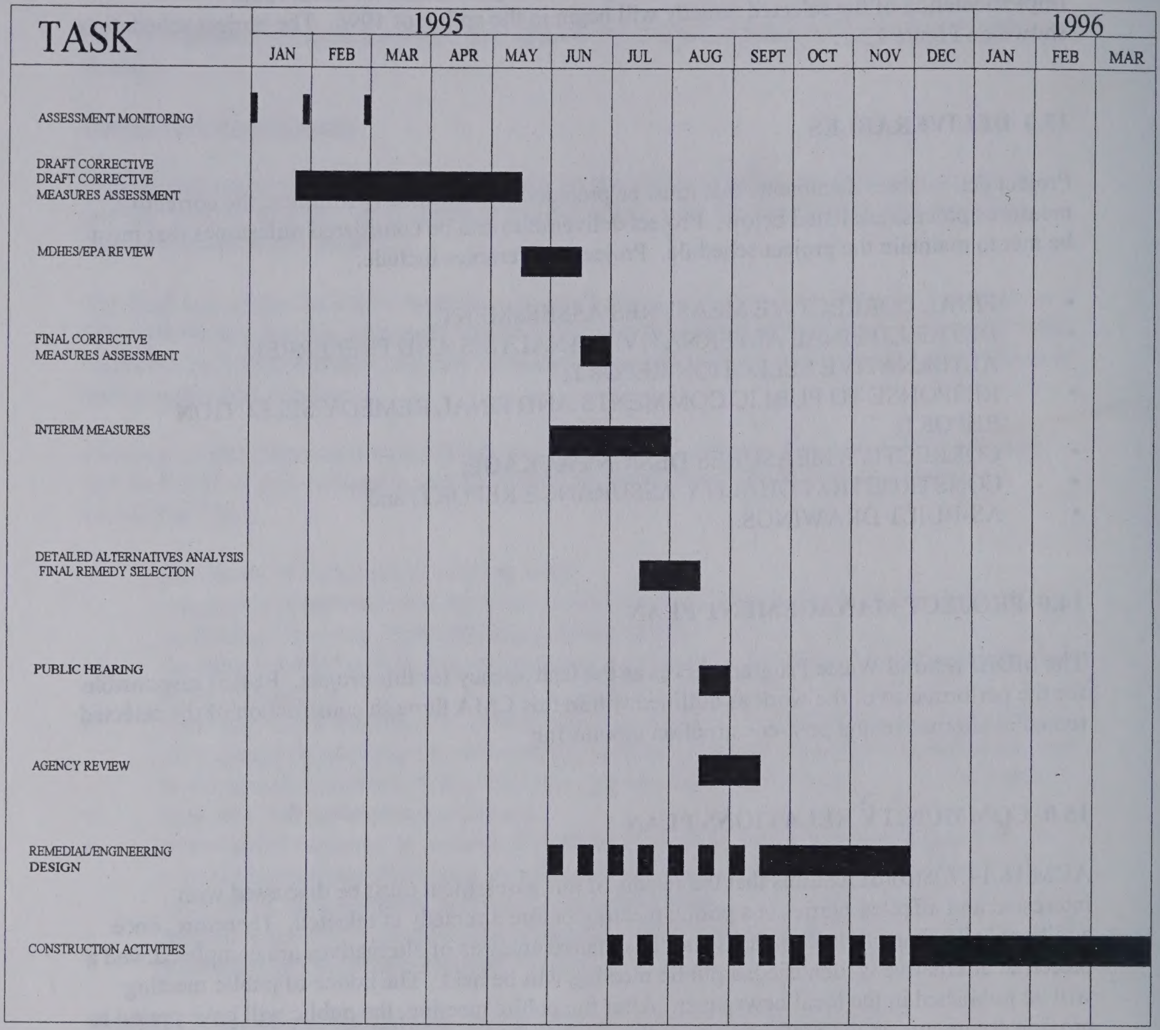


FIGURE 12-1
BSB LANDFILL/CLARK TAILINGS
PROJECT SCHEDULE

PIONEER
TECHNICAL SERVICES, INC.

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ATTACHMENTS
1 THROUGH 4

Attachment 1

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES
Waste Management Division
Solid Waste Program
406/444-1430

FAX # (406) 444-1499

STATE OF MONTANA

OFFICE LOCATION: 2209 PHOENIX AVE. HELENA, MONTANA

MAILING ADDRESS: PO BOX 200901 HELENA, MT 59620-0901

December 23, 1994

Gary Keeler
Landfill Manager
Butte-Silver Bow County
Courthouse
Butte, MT 59701

Dear Gary:

The Department has received the assessment monitoring test results (Table 2) from the Old Butte Landfill. The cover letter from Pioneer Technical Services indicates that the last of the organic data was received on December 1, 1994. The Department will use that date for the start of the next required sequence of events even though knowledge of the exceedance of the ground water protection standard for thallium was known earlier to Pioneer. They were apparently not knowledgable of the requirements of ARM 16.14.708(4) which requires Department notification within 14 days of the discovery.

The detection of Table 2 constituents above the ground water protection standard triggers a series of events with specific deadlines. The first requirement is stated in ARM 16.14.708(1)(a)(iv):

> For any constituent detected in the downgradient wells as a result of the complete Table 2 analysis, collect and analyze a minimum of four independent samples from each well (downgradient and upgradient) to establish background for the constituents detected;

The landfill must continue assessment monitoring as specified in ARM 16.14.708(1)(a)(v). During continued assessment monitoring the owner or operator must:

(A) Sample all wells for all Table 2 constituents at least annually;

(B) Sample all wells within 90 days and at least semi-annually thereafter for all Table 1 constituents and all Table 2 constituents detected in the initial, or subsequent annual, Table 2 sampling; and

(C) Collect and analyze at least one sample from each well (background and downgradient) during each sampling event.

(D) For any constituent detected in the downgradient wells as a result of the Table 2 analysis, collect and analyze a minimum of four independent samples from each well (downgradient and upgradient) to establish background for the constituents detected;

Based on recent correspondence with the EPA, the initial Table 2 sampling and the previous Table 1 sampling can be used to count toward the four required samples. Thus if an analyte was detected in both events, only two re-samples for that analyte are needed. If a substance was only on the Table 2 list, then three samples are needed. The EPA suggests that to maintain independence of the samples, 30 days should elapse between sampling events. The landfill should thus sample the wells around the first of January and the first of February for the Table 2 detects and the first of March for the Table 2 detects and Table 1 constituents, as required by (B) above.

While this sampling is going on, ARM 16.14.708(4) specifies that a landfill which has exceeded a ground water protection standard:

> "(a)(i) Must characterize the nature and extent of the release by installing additional monitoring wells as necessary;
> (ii) Must install at least one additional monitoring well at the facility boundary in the direction of contaminant migration and sample this well for all Table 2 constituents;
> (iii) Must notify all persons who own the land or reside on the land that directly overlies any part of the plume of contamination if contaminants have migrated off-site if indicated by sampling of wells; and
> (iv) Must initiate an assessment of corrective measures within 90 days;".

In order to do an assessment of corrective measures, it is necessary to determine the extent of the problem. Please contact the Department promptly so that we can come to an understanding on the number of additional monitoring wells that may be required at this facility. The Department may be able to provide some additional technical assistance on the ground water flow in the area based on information developed for Superfund sites in Butte.

ARM 16.14.708(6)(a) requires:

> Within 90 days of finding that any of the constituents listed in Table 2 (ARM 16.14.706) have been detected at a statistically significant level exceeding the ground water protection standards defined under (5) of this rule, the owner or operator must initiate an assessment of corrective measures. Such an assessment must be completed within a reasonable period of time, not to exceed an additional 60 days, and be submitted to the department.

The corrective measures assessment must be initiated by March 1, 1995 and completed by April 30, 1995.

I would like to refer you to the requirements of ARM 16.14.708(6) which discusses the assessment of corrective measures, including the need to hold a public hearing prior to selection of remedy; ARM 16.14.708(7), which discusses remedy requirements; and ARM 16.14.708(8), which discusses implementation of the remedy, interim protection measures, and completion schedules; rather than quote the entire sections of the rules.

You should be aware that discussions are currently underway to decide whether the remediation of the Old Butte Landfill and the Clark Tailings should be handled under federal Superfund (CERCLA) or this program. That both the Clark Tailings and Old Butte Landfill should be remediated as "one facility" is not in dispute and in fact has been requested by officials representing Butte-Silver Bow and the Atlantic Richfield Company (ARCO). Which program assumes final authority for corrective action does not set aside current requirements for the assessment of corrective measures at the landfill. Regardless of which program assumes remediation authority, all future corrective action should be broadened to include and take into consideration the entire facility (i.e., Old Butte Landfill and Clark Tailings).

We realize the time deadlines are short; however, we will work with you to assure compliance in a timely fashion. If you have any further questions on this matter, please contact me.

Sincerely,

F Patrick Crowley

F. Patrick Crowley
Solid Waste Regulatory Lead

cc: Jimmy Johnson, DPW, Butte-Silver Bow

File:Old Butte landfill\ground water
Path:H:\cb5403\wp\landfill\groundwater\butte\ACM.NOT

Attachment 2
Jon Sesso
Dan Dennehy
Jim Johnston

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENC
DIRECTOR'S OFFICE

STATE OF MONTANA

(406) 444-2544 (OFFICE)
(406) 444-1804 (FAX)

HELENA, MONTANA 59620-0901

RECEIVED
MAR 27 1995

March 23, 1995

Mr. Jack Lynch
Butte-Silver Bow County
155 West Granite Street
Butte, Montana 58701

Dear Mr. Lynch:

At a number of meetings over the past several months, Butte-Silver Bow County (BSB), the Montana Department of Health and Environmental Sciences (MDHES), the U.S. Environmental Protection Agency (EPA), and several potentially responsible parties have discussed the possibility of integrating the cleanup of the Clark Tailings with the closure of the old Butte-Silver Bow landfill. Butte-Silver Bow has suggested that a combined cleanup be conducted under RCRA authorities under the supervision and direction of the MDHES Solid Waste Program.

MDHES agrees with the proposed approach provided that the following conditions are met to insure that the cleanup of both parts of this site can be completed in an efficient, timely, cost-effective, and thorough manner:

1. Butte-Silver Bow needs formally to commit to completing the cleanup action for those areas of the combined action that are physically outside of the present boundaries of the Butte-Silver Bow Landfill. This is necessary because the regulatory authority of the Solid Waste Program, under RCRA, is limited to the actual landfill property. The commitment could take the form of a memorandum of agreement or letter signed jointly by BSB and MDHES. Failure to complete the necessary action for the Clark Tailings portion of the site would revert that cleanup to the EPA Superfund program.

2. The MDHES Superfund Program will provide staff and technical support to the Solid Waste Program to help deal with the Clark Tailings portion of the site. That support will be provided through EPA cooperative agreement funding which will ultimately be cost recovered by EPA from the Priority Soils PRPs. We understand that EPA is also willing to provide direct support from its technical contractor.

3. BSB will commit to evaluating an appropriate range of alternatives consistent with the landfill closure requirements under RCRA prior to the selection of a final cleanup and closure option. Methods to prevent the spread of groundwater contamination will

need to be considered. Although it is appropriate to consider likely future uses of the property, for instance, recreational use, in evaluating alternatives, the basis for determining future uses should be clearly identified and documented.

4. BSB will need to involve the public fully in the evaluation and selection of corrective action and closure options for the combined site.

If the 1995 legislature substantially reduces the funding or staffing levels for the MDHES Solid Waste Program, then the Department may not be able to oversee the cleanup in an efficient manner. We would probably have to request that the Clark Tailings portion of the site revert to EPA Superfund authorities in that case.

Please feel free to contact either me or Pat Crowley of our Solid Waste Program regarding this action.

Sincerely,

Robert J. Robinson
Director

cc: John Wardell, EPA
Jim Scott, MDHES
Pat Crowley, MDHES

Attachment 3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, MONTANA OFFICE
FEDERAL BUILDING, 301 S. PARK, DRAWER 10096
HELENA, MONTANA 59626-0096

Ref: 8MO

March 1, 1995

Mr. Jack Lynch
Chief Executive
Butte-Silver Bow
155 West Granite St.
Butte, Montana 58701

Dear Jack:

We have discussed on several occasions ways to speed the cleanup of the Clark Tailings by integrating that cleanup with the closure of the Butte-Silver Bow landfill. Recent staff level discussions among Butte-Silver Bow, EPA and the State have shown there is a common desire to initiate this integrated cleanup using the authorities contained in the RCRA law. By this letter, EPA endorses this proposal and stands ready to assist in this effort.

EPA believes it makes sense to implement an integrated cleanup/closure because the tailings are partially intermixed with the landfill and because the contaminants associated with the tailings and the landfill are also intermixed. Any remedy will have to deal with these contaminants as a combined source. We are confident that the technical RCRA requirements for landfill closure would be appropriate for containing the Clark Tailings. EPA would be willing to provide contractor technical assistance to the State RCRA staff to the extent that RCRA staff may need assistance in dealing with wastes normally handled under CERCLA (the Clark Tailings). It should be noted that if there is a failure to comply with the requirements under RCRA, the Clark Tailings cleanup would revert to the jurisdiction of CERCLA.

I believe this integrated cleanup approach using all available legal authorities is a good step in streamlining the Superfund cleanup process. We look forward to rapid progress on this project.

Please contact me if you have any questions or concerns about this issue.

Sincerely,

John F. Wardell
John F. Wardell,
Montana Office Director

cc: Bob Robinson

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Attachment 4

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES
Waste Management Division
Solid Waste Management Program
406/444-1430
FAX # (406) 444-1902

STATE OF MONTANA

OFFICE LOCATION: 2209 PHOENIX AVE. HELENA, MONTANA
MAILING ADDRESS: PO BOX 200901 HELENA, MT 59620-0901

RECEIVED
FEB 3 1995

February 2, 1995

Mr. James Johnston
Department of Public Works
Butte-Silver Bow County
Butte-Silver Bow County Courthouse
155 West Granite
Butte, Montana 59701

Subject: Old Butte-Silver Bow Landfill, License #20, Temporary C&D Disposal Site

Dear Jimmy:

I would like to thank you and Mike Shea for taking the time to meet with me and other program staff to discuss the possibility of using the old Butte-Silver Bow Landfill as a temporary construction and demolition (C&D) disposal area. Based on the Program's review of the conditions and operational modifications you submitted for the conversion, the Program believes that the idea is workable and appropriate. However, as we discussed during our meeting there are a few additional changes and conditions we need to request to make the temporary disposal area approvable. Below I have listed and discuss these additions:

1. The C&D wastes must be covered with six inches of earthen cover material on a bi-weekly basis at a minimum. More frequent cover will be required if litter, insect, or rodent harborage become problems. The Program also strongly recommends the consideration of alternative daily cover materials for covering the waste on a daily basis. Since C&D waste does contain components that may leach out toxic materials if exposed to water, it is our concern that the wastes do not become saturated while exposed. The old Butte-Silver Bow Landfill is already experiencing possible ground water contamination problems and it would be unfortunate to have this area add to the problems. Another reason for the consideration of ADC is the high frequency of gypsum found in C&D wastes. When gypsum board becomes wet and starts to decompose it releases hydrogen sulfide gas. This gas can be highly toxic to humans if inhaled in sufficient dosage. The use of ADC would help to keep moisture out of the waste and prevent or reduce the generation of this gas.

2. Many fixtures in a building contain significant sources of contaminants that can be released into the environment on disposal. Examples include: lights and light fixtures (mercury and PCB oils), carpets (formaldehyde and other VOCs), and copper and lead piping (metals).

"AN EQUAL OPPORTUNITY EMPLOYER"

To help eliminate potential impacts to the environment from this type of material in the exposed C&D wastes, the Program requests that lights, light fixtures, carpets, and metal piping be removed from the buildings to the greatest extent possible prior to demolition and delivery to the disposal site. The removed materials can be reused, recycled, or disposed of in the new Butte-Silver Bow Class II Landfill.

3. Since the use of the proposed area for C&D disposal was not anticipated in the original closure plan and surface water run-on/run-off plans for this landfill, the use of the site in this manner will ultimately need to be addressed in these plans. Changes in the final topographic contours, drainage pathways and controls of the closure plan will need to be made to the plan on file with the Department. This should be accomplished as soon as possible because the needs of the closure plans may dictate where and how high disposal of C&D wastes can occur in the proposed area.

4. As a separate but related issue, plans for the development of a methane gas monitoring system for the landfill will need to be addressed in the very near future. Since the landfill was unable to complete closure by October, 1994, and since the site will be continuing to receive wastes for a temporary period, a system to monitor for the generation and possible migration off site of explosive gases is needed. Such a system need not be expensive or complicated and may be able to be worked into future activities concerning the groundwater contamination and closure of the site.

In consideration of the operations plan changes you submitted to the Program on January 24, 1995, and with understanding and agreement on the above listed additional conditions as we discussed in our meeting, your plans to operate a temporary construction and demolition disposal area at the old Butte-Silver Bow Landfill, License #20, is approved. Please contact the Program with a proposed schedule for the opening of the site and the hours of operation as soon as they are available.

Thank you for your cooperation in this matter. Please do not hesitate to contact me or other staff members of the Program if you have any questions.

Sincerely,

Jon A Dilliard

Jon A. Dilliard
cb5415\wp\sw\ltr95\Johnston.127

APPENDIX A

MONTANA BUREAU OF MINES AND GEOLOGY GROVE CREEK DATA

MONTANA TECH
of The University of Montana

Montana Bureau of Mines and Geology
1300 West Park Street
Butte, Montana 59701-8997
(406) 496-4180

April 3, 1995

Mr. Brad Archibald
Pioneer Technical Services, Inc.
P.O. Box 3445
Butte, MT 59702

Dear Brad:

Enclosed are copies of water quality data from surface water samples collected by the Montana Bureau of Mines and Geology (MBMG). Sites sampled were Grove Creek, Silver Bow Creek, Blacktail Creek, and Missoula Gulch.

This data is from the Grove Creek report you called inquiring about. As I mentioned at that time, this report is still in Draft stage, however, in discussions with Jim Scott, MDHES, he has approved the release of the analytical data, which I believe was your main interest.

I hope you find the enclosed data helpful. Do not hesitate to call if you have further questions.

Sincerely,

Ted

Ted Duaime
Hydrogeologist

Enclosures
c: Jim Scott, MDHES

TD/bb

UPPER CLARK FORK BASIN WATER QUALITY SAMPLING
(Silver Bow Cr., Blacktail Cr., Grove Creek, and Missoula Gulch)
4/ 2/1993

TABLE 1

					PHYSICAL PARAMETERS										PERCENT MEQ/L			
	DATE (MM/DD/YR)	TIME (HRS)	FLOW (CFS)	FLOW (GPM)	FIELD SC (UMHOS)	pH	Eh (mv)	TEMP (C)	LAB SC (UMHOS)	PH	HARDNESS (MG/L)	ALKALINITY (MG/L)	Ca	Mg	Na	HCO3	CO3	SO4
BLACKTAIL CREEK AT FATHER SHEEHAN PARK																		
GC-6	5/15/1991	18:10	15.8	7110	180	7.7	257.3	12.8	196	7.5	76.5	55.0	58.4	21.7	16.2	62.1	.0	30.8
	3/ 6/1992	14:25	7.1	3195	234	7.4	236.0	9.1	255	7.9	96.7	83.4	56.2	23.8	16.9	66.7	.0	26.9
	6/19/1992	14:00	3.5	1589	310	7.7	257.0	22.7	280	8.0	103.4	98.4	55.8	24.2	17.8	70.1	.0	24.2
	8/20/1992	14:10	2.3	1030	305	7.5	-46.8	15.8	313	7.9	126.8	109.9	57.2	23.2	17.6	71.6	.0	23.4
BLACKTAIL CREEK ABOVE CONFLUENCE WITH GROVE CREEK																		
GC-5	5/15/1991	17:00	20.2	9090	280	7.6	288.1	15.5	233	7.5	87.8	66.1	58.7	20.9	17.1	62.3	.0	30.0
	3/ 6/1992	15:00	9.3	4185	248	7.7	262.2	10.5	278	7.9	106.2	96.5	56.5	23.6	17.1	68.6	.0	24.8
	6/19/1992	14:50	7.8	3510	425	7.7	246.0	25.3	340	7.8	137.5	110.7	56.6	23.5	17.9	66.1	.0	26.7
	8/20/1992	17:00	6.3	2841	327	7.1	-31.3	18.5	354	7.7	136.7	113.2	57.8	22.5	17.0	67.0	.0	25.3
GROVE CREEK (ABOVE BSB LANDFILL)																		
GC-1	5/15/1991	11:10	.7	315	295	8.1	96.5	9.5	340	7.8	130.1	78.2	55.9	21.0	19.6	51.1	.0	42.2
	3/ 6/1992	10:41	.4	180	276	8.2	27.4	3.3	297	7.6	106.5	73.6	54.3	21.3	18.2	50.9	.0	42.5
	6/19/1992	11:12	.2	68	360	7.6	249.3	17.0	420	7.9	181.1	132.1	60.1	21.5	15.9	61.8	.0	33.1
	8/20/1992	12:40	.0	2	372	7.7	-66.5	19.0	424	8.2	167.9	150.9	57.8	21.4	16.9	70.9	.0	25.3
GROVE CREEK (BELOW BSB LANDFILL, @ MT ST)																		
GC-2	5/15/1991	12:30	1.1	495	440	7.6	138.8	11.7	430	7.4	167.4	115.2	56.7	21.1	18.8	54.3	.0	35.5
	3/ 6/1992		.4	180	385	8.1	N/A	6.5	408	7.6	152.9	107.3	56.4	21.4	17.3	53.0	.0	37.4
	6/19/1992	11:23	.3	135	469	7.3	229.1	16.9	510	7.5	213.3	162.3	57.3	22.7	16.9	61.2	.0	27.8
	8/20/1992	13:00	.0	22	540	7.2	-26.9	12.1	580	7.6	232.0	192.7	58.1	22.3	16.7	64.4	.0	23.3
GROVE CREEK ABOVE CONFLUENCE WITH BLACKTAIL CREEK																		
GC-3	5/15/1991	13:50	.2	90	460	7.7	243.8	17.4	470	7.9	181.3	124.5	55.2	20.4	20.6	52.9	.0	35.7
	3/ 6/1992	13:05	.1	45	476	7.8	129.8	6.5	490	7.5	180.0	122.5	55.2	20.9	19.1	50.5	.0	37.0
	6/19/1992	16:00	N/A	N/A	770	7.1	113.0	25.3	880	7.4	326.1	276.6	50.8	20.8	24.3	58.5	.0	26.4
	8/20/1992	13:30	.0	3	490	7.0	-18.8	15.0	510	7.0	176.5	78.1	54.3	17.8	19.8	33.0	.0	48.8
BLACKTAIL CREEK ABOVE CONFLUENCE WITH SBC (USGS GAGE)																		
GC-4	5/15/1991	15:06	19.1	8595	240	7.9	305.8	13.0	248	7.6	99.0	71.9	58.2	21.9	16.8	62.5	.0	29.4
SS-04	3/ 6/1992	15:30	11.0	4950	305	7.8	244.7	9.1	327	7.8	126.3	96.3	56.2	23.0	18.0	61.6	.0	30.5
	6/19/1992	13:40	19.4	8730	412	7.7	244.0	23.5	359	8.1	141.5	121.3	56.6	23.2	17.9	66.8	.0	25.8
	8/21/1992	09:30	13.0	5850	346	7.4	-36.5	12.4	386	7.5	160.2	123.0	58.0	22.6	16.9	64.5	.0	27.7
	6/12/1992	07:00	10.0	4500	360	7.4	N/A	18.9	412	7.4	152.4	117.0	55.2	21.6	19.1	60.5	.0	30.2
SILVER BOW CREEK AT TEXAS AVE. (METRO STORM DRAIN)																		
SS-02	6/11/1992	16:30	.0	0	180	6.8	N/A	19.1	212	6.7	82.5	26.2	73.7	9.1	12.5	27.4	.0	62.1
SILVER BOW CREEK BELOW CONFLUENCE WITH BLACKTAIL CR. (@ MT ST)																		
TM-01	6/12/1992	07:30	N/A	N/A	440	7.1	N/A	19.5	724	7.3	165.0	107.0	57.1	21.3	17.8	53.2	.0	37.8
	6/19/1992	09:43	10.4	4680	387	7.6	239.7	13.3	404	7.8	156.6	116.5	56.0	23.7	18.2	58.4	.0	34.3
	8/20/1992	11:50	15.4	6930	377	6.7	-14.2	13.4	394	7.4	161.8	93.5	60.8	21.6	15.0	49.1	.0	43.9
MISSOULA GULCH (@ CENTENNIAL AVE.)																		
TM-02	6/11/1992	17:45	N/A	N/A	510	7.4	N/A	18.0	561	7.5	230.4	92.4	64.7	19.4	13.7	33.8	.0	56.1
	6/20/1992	11:00	.6	251	424	6.1	13.1	14.1	458	7.1	172.2	29.5	61.7	24.8	10.5	13.6	.0	80.8
SILVER BOW CREEK BELOW COLORADO TAILINGS (@ USGS GAGE)																		
SS-07	6/12/1992	08:00	19.0	8550	480	7.2	N/A	17.9	548	7.2	182.4	111.8	54.1	18.5	21.5	41.6	.0	46.3
	6/19/1992	12:55	20.0	9000	605	7.1	309.7	19.5	530	7.4	169.2	97.6	51.3	20.7	24.8	41.4	.0	45.4
	8/21/1992	09:45	17.0	7650	400	7.1	-21.5	15.9	540	7.4	183.4	117.3	50.9	21.0	24.8	47.0	.0	39.8

N/A - NOT ANALYIZED

PHYSICAL PARAMETERS

					FIELD				LAB														
	DATE (MM/DD/YR)	TIME (HRS)	FLOW (CFS)	FLOW (GPM)	SC (UMHOS)	pH	Eh (mv)	TEMP (C)	SC (UMHOS)	PH	Ca (MG/L)	Mg (MG/L)	Na (MG/L)	K (MG/L)	Fe (MG/L)	Mn (MG/L)	SiO2 (MG/L)	HCO3 (MG/L)	CO3 (MG/L)	Cl (MG/L)	SO4 (MG/L)	NO3-N (MG/L)	F (MG/L)
BLACKTAIL CREEK AT FATHER SHEEHAN PARK																							
GC-6	5/15/1991	18:10	15.8	7110	180	7.7	257.3	12.8	196	7.5	22.3	5.0	7.1	2.8	.58	.02	18.6	67.1	.0	4.5	26.2	.35	.32
	3/ 6/1992	14:25	7.1	3195	234	7.4	236.0	9.1	255	7.9	27.2	7.0	9.4	2.9	.17	.06	25.2	101.7	.0	5.6	32.3	.79	.34
	6/19/1992	14:00	3.5	1589	310	7.7	257.0	22.7	280	8.0	28.9	7.6	10.6	2.2	.08	.02	25.1	120.0	.0	5.4	32.9	.82	.41
	8/20/1992	14:10	2.3	1030	305	7.5	-46.8	15.8	313	7.9	36.1	8.9	12.7	2.4	.07	.02	28.3	134.0	.0	5.4	34.5	1.31	.61
BLACKTAIL CREEK ABOVE CONFLUENCE WITH GROVE CREEK																							
GC-5	5/15/1991	17:00	20.2	9090	280	7.6	288.1	15.5	233	7.5	25.9	5.6	8.7	2.9	.48	.03	20.0	80.6	.0	5.8	30.6	.79	.33
	3/ 6/1992	15:00	9.3	4185	248	7.7	262.2	10.5	278	7.9	30.0	7.6	10.4	2.9	.15	.04	26.7	117.6	.0	6.6	33.4	1.26	.36
	6/19/1992	14:50	7.8	3510	425	7.7	246.0	25.3	340	7.8	38.9	9.8	14.1	2.7	.06	.02	29.0	135.0	.0	8.5	42.9	1.83	.39
	8/20/1992	17:00	6.3	2841	327	7.1	-31.3	18.5	354	7.7	39.4	9.3	13.3	3.5	.06	.02	26.8	138.0	.0	9.2	41.0	1.98	.67
GROVE CREEK (ABOVE BSB LANDFILL)																							
GC-1	5/15/1991	11:10	.7	315	295	8.1	96.5	9.5	340	7.8	37.9	8.6	15.3	4.7	.15	.06	23.9	95.4	.0	7.3	62.1	.15	.54
	3/ 6/1992	10:41	.4	180	276	8.2	27.4	3.3	297	7.6	30.6	7.3	11.8	6.8	.25	.17	1.0	90.0	.0	6.7	59.2	.23	.50
	6/19/1992	11:12	.2	68	360	7.6	249.3	17.0	420	7.9	53.4	11.6	16.2	4.3	.07	.09	36.0	161.0	.0	7.8	67.9	.07	1.22
	8/20/1992	12:40	.0	2	372	7.7	-66.5	19.0	424	8.2	49.1	11.0	16.5	6.4	.10	.04	36.0	184.0	.0	5.7	51.6	<0.1	.54
GROVE CREEK (BELOW BSB LANDFILL, @ MT ST)																							
GC-2	5/15/1991	12:30	1.1	495	440	7.6	138.8	11.7	430	7.4	48.9	11.0	18.6	5.6	.60	.83	24.9	140.5	.0	15.4	72.3	.10	.78
	3/ 6/1992		.4	180	385	8.1	N/A	6.5	408	7.6	44.4	10.2	15.6	7.5	.53	.76	25.6	130.8	.0	13.8	72.6	.36	.67
	6/19/1992	11:23	.3	135	469	7.3	229.1	16.9	510	7.5	61.2	14.7	20.7	6.6	.18	1.54	28.2	197.9	.0	20.7	70.9	.05	1.00
	8/20/1992	13:00	.0	22	540	7.2	-26.9	12.1	580	7.6	67.2	15.6	22.1	6.6	2.55	3.93	34.8	235.0	.0	26.0	67.0	1.28	.69
GROVE CREEK ABOVE CONFLUENCE WITH BLACKTAIL CREEK																							
GC-3	5/15/1991	13:50	.2	90	460	7.7	243.8	17.4	470	7.9	53.0	11.9	22.6	7.1	.34	.31	1.0	151.8	.0	19.0	80.8	.23	.92
	3/ 6/1992	13:05	.1	45	476	7.8	129.8	6.5	490	7.5	52.3	12.0	20.8	8.8	.51	1.86	25.0	149.3	.0	21.5	86.3	.36	1.00
	6/19/1992	16:00	N/A	N/A	770	7.1	113.0	25.3	880	7.4	92.7	23.0	51.0	14.7	.30	2.35	36.6	337.2	.0	50.4	120.0	<0.1	2.69
	8/20/1992	13:30	.0	3	490	7.0	-18.8	15.0	510	7.0	53.2	10.6	22.2	15.4	.23	2.42	22.6	95.2	.0	30.6	111.0	3.01	.66
BLACKTAIL CREEK ABOVE CONFLUENCE WITH SBC (USGS GAGE)																							
GC-4	5/15/1991	15:06	19.1	8595	240	7.9	305.8	13.0	248	7.6	28.8	6.6	9.5	3.0	.47	.05	20.1	87.6	.0	6.6	32.4	.90	.38
SS-04	3/ 6/1992	15:30	11.0	4950	305	7.8	244.7	9.1	327	7.8	35.9	8.9	13.2	3.5	.15	.96	27.4	117.4	.0	8.8	45.7	1.28	.44
	6/19/1992	13:40	19.4	8730	412	7.7	244.0	23.5	359	8.1	40.2	10.0	14.6	3.1	.13	.08	26.6	147.9	.0	9.5	45.0	<0.1	.52
	8/21/1992	09:30	13.0	5850	346	7.4	-36.5	12.4	386	7.5	46.2	10.9	15.4	4.0	.08	.09	31.7	150.0	.0	10.6	50.7	2.10	.59
	6/12/1992	07:00	10.0	4500	360	7.4	N/A	18.9	412	7.4	43.9	10.4	17.4	6.4	.18	.19	26.5	142.6	.0	12.7	56.0	3.18	.77
SILVER BOW CREEK AT TEXAS AVE. (METRO STORM DRAIN)																							
SS-02	6/11/1992	16:30	.0	0	180	6.8	N/A	19.1	212	6.7	29.4	2.2	5.7	3.7	.04	.61	6.7	32.0	.0	7.1	56.9	1.32	1.43
SILVER BOW CREEK BELOW CONFLUENCE WITH BLACKTAIL CR. (@ MT ST)																							
TM-01	6/12/1992	07:30	N/A	N/A	440	7.1	N/A	19.5	724	7.3	48.1	10.9	17.2	6.1	.16	.41	26.8	130.5	.0	12.8	72.9	2.58	.84
	6/19/1992	09:43	10.4	4680	387	7.6	239.7	13.3	404	7.8	44.1	11.3	16.4	3.3	.07	.36	26.3	142.0	.0	10.3	65.7	1.45	.60
	8/20/1992	11:50	15.4	6930	377	6.7	-14.2	13.4	394	7.4	47.8	10.3	13.5	4.0	.09	.50	23.4	114.0	.0	9.5	80.3	1.73	.93
MISSOULA GULCH (@ CENTENNIAL AVE.)																							
TM-02	6/11/1992	17:45	N/A	N/A	510	7.4	N/A	18.0	561	7.5	71.0	12.9	17.3	4.8	.01	1.57	22.7	112.6	.0	19.5	147.0	3.56	1.26
	6/20/1992	11:00	.6	251	424	6.1	13.1	14.1	458	7.1	49.2	12.0	9.6	4.7	.01	4.25	14.5	36.0	.0	8.7	169.0	1.29	1.11
SILVER BOW CREEK BELOW COLORADO TAILINGS (@ USGS GAGE)																							
SS-07	6/12/1992	08:00	19.0	8550	480	7.2	N/A	17.9	548	7.2	54.4	11.3	24.8	11.5	.31	1.58	22.5	136.3	.0	23.0	119.5	5.82	.91
	6/19/1992	12:55	20.0	9000	605	7.1	309.7	19.5	530	7.4	48.3	11.8	26.8	5.9	.16	1.25	26.3	119.0	.0	22.0	102.6	.96	.70
	8/21/1992	09:45	17.0	7650	400	7.1	-21.5	15.9	540	7.4	52.0	13.0	29.0	6.6	.13	.96	25.3	143.0	.0	23.3	95.3	3.80	.65

N/A - NOT ANALYIZED

UPPER CLARK FORK BASIN WATER QUALITY SAMPLING
(Silver Bow Cr., Blacktail Cr., Grove Creek, and Missoula Gulch)
4/ 2/1993

TABLE 1 (cont.)

					PHYSICAL PARAMETERS						DISSOLVED CONCENTRATION												
					FIELD				LAB														
	DATE (MM/DD/YR)	TIME (HRS)	FLOW (CFS)	FLOW (GPM)	SC (UMHOS)	pH	Eh (mv)	TEMP (C)	SC (UMHOS)	PH	Al (UG/L)	Ag (UG/L)	As (UG/L)	B (UG/L)	Ba (UG/L)	Be (UG/L)	Cd (UG/L)	Cr (UG/L)	Cu (UG/L)	Li (UG/L)	Pb (UG/L)	Sr (UG/L)	Zn (UG/L)
BLACKTAIL CREEK AT FATHER SHEEHAN PARK																							
GC-6	5/15/1991	18:10	15.8	7110	180	7.7	257.3	12.8	196	7.5	348	<4	6.1	<40	31	N/A	<5	<5	20	4	<40	135	<6
	3/ 6/1992	14:25	7.1	3195	234	7.4	236.0	9.1	255	7.9	<100	<6	3.0	<100	N/A	N/A	<1	<6	5	6	<1	168	8
	6/19/1992	14:00	3.5	1589	310	7.7	257.0	22.7	280	8.0	<100	<10	5.2	<100	N/A	N/A	<6	<10	<10	<6	<100	187	<10
	8/20/1992	14:10	2.3	1030	305	7.5	-46.8	15.8	313	7.9	<50	<1	3.3	<100	56.9	<0.5	<2	<2	4	<6	<3	225	12
BLACKTAIL CREEK ABOVE CONFLUENCE WITH GROVE CREEK																							
GC-5	5/15/1991	17:00	20.2	9090	280	7.6	288.1	15.5	233	7.5	331	<4	5.5	70	32	N/A	<5	<5	19	4	<40	149	4
	3/ 6/1992	15:00	9.3	4185	248	7.7	262.2	10.5	278	7.9	<100	<6	3.0	<100	N/A	N/A	<1	<6	5	<6	<1	185	9
	6/19/1992	14:50	7.8	3510	425	7.7	246.0	25.3	340	7.8	<100	<10	4.9	<100	N/A	N/A	<6	<10	<10	8	<100	240	7
	8/20/1992	17:00	6.3	2841	327	7.1	-31.3	18.5	354	7.7	<100	<1	3.3	<100	54.1	<0.5	<2	<2	9	<6	<3	228	26
GROVE CREEK (ABOVE BSB LANDFILL)																							
GC-1	5/15/1991	11:10	.7	315	295	8.1	96.5	9.5	340	7.8	<40	<4	5.3	130	35	N/A	5	<5	21	12	<40	228	176
	3/ 6/1992	10:41	.4	180	276	8.2	27.4	3.3	297	7.6	<100	<6	8.0	131	N/A	N/A	<1	<6	11	<6	1	191	20
	6/19/1992	11:12	.2	68	360	7.6	249.3	17.0	420	7.9	<100	<10	6.9	<100	N/A	N/A	<6	<10	12	20	<100	311	<10
	8/20/1992	12:40	.0	2	372	7.7	-66.5	19.0	424	8.2	<100	<1	6.4	<100	50.3	<0.5	<2	<2	18	<6	<3	272	20
GROVE CREEK (BELOW BSB LANDFILL, @ MT ST)																							
GC-2	5/15/1991	12:30	1.1	495	440	7.6	138.8	11.7	430	7.4	258	<4	7.2	125	38	N/A	<5	<5	19	9	<40	280	53
	3/ 6/1992		.4	180	385	8.1	N/A	6.5	408	7.6	<100	<6	7.0	<100	N/A	N/A	<1	<6	5	6	<1	249	30
	6/19/1992	11:23	.3	135	469	7.3	229.1	16.9	510	7.5	<100	<10	10.0	<100	N/A	N/A	<6	<10	<10	7	<100	350	20
	8/20/1992	13:00	.0	22	540	7.2	-26.9	12.1	580	7.6	<100	<1	14.7	<100	67.9	<0.5	<2	<2	2	<6	<1	376	36
GROVE CREEK ABOVE CONFLUENCE WITH BLACKTAIL CREEK																							
GC-3	5/15/1991	13:50	.2	90	460	7.7	243.8	17.4	470	7.9	249	8	12.0	40	34	N/A	<5	<5	44	10	<40	302	37
	3/ 6/1992	13:05	.1	45	476	7.8	129.8	6.5	490	7.5	<100	<6	10.0	<100	N/A	N/A	<1	<6	24	7	<1	310	117
	6/19/1992	16:00	N/A	N/A	770	7.1	113.0	25.3	880	7.4	<100	12	17.6	228	N/A	N/A	<6	<10	<10	<6	<100	590	19
	8/20/1992	13:30	.0	3	490	7.0	-18.8	15.0	510	7.0	<100	<1	19.6	210	48.6	<0.5	<2	<2	50	7	3	252	759
BLACKTAIL CREEK ABOVE CONFLUENCE WITH SBC (USGS GAGE)																							
GC-4	5/15/1991	15:06	19.1	8595	240	7.9	305.8	13.0	248	7.6	127	<4	6.4	<40	37	N/A	<5	<5	9	5	<40	164	<6
SS-04	3/ 6/1992	15:30	11.0	4950	305	7.8	244.7	9.1	327	7.8	<100	<6	6.0	<100	N/A	N/A	<1	<6	4	7	<1	215	15
	6/19/1992	13:40	19.4	8730	412	7.7	244.0	23.5	359	8.1	<100	<10	8.5	<100	N/A	N/A	<6	<10	<10	<6	<100	243	<10
	8/21/1992	09:30	13.0	5850	346	7.4	-36.5	12.4	386	7.5	<100	<10	5.3	<100	58.7	<0.5	<2	<6	5	<6	<1	267	40
	6/12/1992	07:00	10.0	4500	360	7.4	N/A	18.9	412	7.4	<50	<6	17.2	<100	N/A	N/A	<6	<6	33	<6	<50	265	92
SILVER BOW CREEK AT TEXAS AVE. (METRO STORM DRAIN)																							
SS-02	6/11/1992	16:30	.0	0	180	6.8	N/A	19.1	212	6.7	<50	<6	10.2	<100	N/A	N/A	<6	<6	605	<6	<50	59	1050
SILVER BOW CREEK BELOW CONFLUENCE WITH BLACKTAIL CR. (@ MT ST)																							
TM-01	6/12/1992	07:30	N/A	N/A	440	7.1	N/A	19.5	724	7.3	<50	<6	15.5	<100	N/A	N/A	<6	<6	105	6	<50	287	556
	6/19/1992	09:43	10.4	4680	387	7.6	239.7	13.3	404	7.8	<100	10	7.5	<100	N/A	N/A	<6	<10	<10	<6	<100	274	318
	8/20/1992	11:50	15.4	6930	377	6.7	-14.2	13.4	394	7.4	70	<1	4.3	220	49.7	<0.5	5	<1	311	<6	2	247	1261
MISSOULA GULCH (@ CENTENNIAL AVE.)																							
TM-02	6/11/1992	17:45	N/A	N/A	510	7.4	N/A	18.0	561	7.5	<50	<6	4.5	150	N/A	N/A	9	<6	50	10	<50	368	2280
	6/20/1992	11:00	.6	251	424	6.1	13.1	14.1	458	7.1	42	<1	<1	204	41.7	<0.5	30	<2	526	7	<3	249	8520
SILVER BOW CREEK BELOW COLORADO TAILINGS (@ USGS GAGE)																							
SS-07	6/12/1992	08:00	19.0	8550	480	7.2	N/A	17.9	548	7.2	<50	<6	23.0	120	N/A	N/A	<6	<6	322	8	<50	304	2090
	6/19/1992	12:55	20.0	9000	605	7.1	309.7	19.5	530	7.4	<100	<10	12.7	130	N/A	N/A	<6	<10	192	11	<100	300	1620
	8/21/1992	09:45	17.0	7650	400	7.1	-21.5	15.9	540	7.4	<100	<10	11.3	180	34.7	4	2	<6	94	<6	1	316	942

N/A - NOT ANALYIZED

					PHYSICAL PARAMETERS						DISSOLVED METAL LOADING RATE, POUNDS PER DAY						
					FIELD				LAB								
	DATE (MM/DD/YR)	TIME (HRS)	FLOW (CFS)	FLOW (GPM)	SC (UMHOS)	pH	Eh (mv)	TEMP (C)	SC (UMHOS)	PH	Fe (lb/d)	Mn (lb/d)	SO4 (lb/d)	Al (lb/d)	As (lb/d)	Cu (lb/d)	Zn (lb/d)
BLACKTAIL CREEK AT FATHER SHEEHAN PARK																	
GC-6	5/15/1991	18:10	15.8	7110	180	7.7	257.3	12.8	196	7.5	49.56	2.04	2231.24	29.64	.52	1.70	.00
	3/ 6/1992	14:25	7.1	3195	234	7.4	236.0	9.1	255	7.9	6.62	2.10	1236.09	.00	.11	.19	.31
	6/19/1992	14:00	3.5	1589	310	7.7	257.0	22.7	280	8.0	1.60	.38	625.98	.00	.10	.00	.00
	8/20/1992	14:10	2.3	1030	305	7.5	-46.8	15.8	313	7.9	.88	.30	425.63	.00	.04	.05	.15
BLACKTAIL CREEK ABOVE CONFLUENCE WITH GROVE CREEK																	
GC-5	5/15/1991	17:00	20.2	9090	280	7.6	288.1	15.5	233	7.5	52.26	3.05	3331.67	36.04	.60	2.07	.44
	3/ 6/1992	15:00	9.3	4185	248	7.7	262.2	10.5	278	7.9	7.62	1.90	1674.24	.00	.15	.25	.45
	6/19/1992	14:50	7.8	3510	425	7.7	246.0	25.3	340	7.8	2.44	1.01	1803.60	.00	.21	.00	.29
	8/20/1992	17:00	6.3	2841	327	7.1	-31.3	18.5	354	7.7	1.87	.78	1395.18	.00	.11	.30	.87
GROVE CREEK (ABOVE BSB LANDFILL)																	
GC-1	5/15/1991	11:10	.7	315	295	8.1	96.5	9.5	340	7.8	.55	.23	234.30	.00	.02	.08	.66
	3/ 6/1992	10:41	.4	180	276	8.2	27.4	3.3	297	7.6	.54	.37	127.64	.00	.02	.02	.04
	6/19/1992	11:12	.2	68	360	7.6	249.3	17.0	420	7.9	.06	.07	54.90	.00	.01	.01	.00
	8/20/1992	12:40	.0	2	372	7.7	-66.5	19.0	424	8.2	.00	.00	1.17	.00	.00	.00	.00
GROVE CREEK (BELOW BSB LANDFILL, @ MT ST)																	
GC-2	5/15/1991	12:30	1.1	495	440	7.6	138.8	11.7	430	7.4	3.56	4.92	428.67	1.53	.04	.11	.31
	3/ 6/1992		.4	180	385	8.1	N/A	6.5	408	7.6	1.15	1.63	156.53	.00	.02	.01	.06
	6/19/1992	11:23	.3	135	469	7.3	229.1	16.9	510	7.5	.29	2.49	114.65	.00	.02	.00	.03
	8/20/1992	13:00	.0	22	540	7.2	-26.9	12.1	580	7.6	.68	1.05	17.82	.00	.00	.00	.01
GROVE CREEK ABOVE CONFLUENCE WITH BLACKTAIL CREEK																	
GC-3	5/15/1991	13:50	.2	90	460	7.7	243.8	17.4	470	7.9	.36	.34	87.10	.27	.01	.05	.04
	3/ 6/1992	13:05	.1	45	476	7.8	129.8	6.5	490	7.5	.27	1.00	46.52	.00	.01	.01	.06
	6/19/1992	16:00	N/A	N/A	770	7.1	113.0	25.3	880	7.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	8/20/1992	13:30	.0	3	490	7.0	-18.8	15.0	510	7.0	.01	.08	3.86	.00	.00	.00	.03
BLACKTAIL CREEK ABOVE CONFLUENCE WITH SBC (USGS GAGE)																	
GC-4	5/15/1991	15:06	19.1	8595	240	7.9	305.8	13.0	248	7.6	47.97	5.56	3335.55	13.07	.66	.93	.00
SS-04	3/ 6/1992	15:30	11.0	4950	305	7.8	244.7	9.1	327	7.8	8.77	56.92	2709.55	.00	.36	.24	.89
	6/19/1992	13:40	19.4	8730	412	7.7	244.0	23.5	359	8.1	13.07	8.26	4705.47	.00	.89	.00	.00
	8/21/1992	09:30	13.0	5850	346	7.4	-36.5	12.4	386	7.5	5.26	6.52	3552.55	.00	.37	.37	2.81
	6/12/1992	07:00	10.0	4500	360	7.4	N/A	18.9	412	7.4	9.81	10.03	3018.40	.00	.93	1.78	4.96
SILVER BOW CREEK AT TEXAS AVE. (METRO STORM DRAIN)																	
SS-02	6/11/1992	16:30	.0	0	180	6.8	N/A	19.1	212	6.7	.00	.00	.00	.00	.00	.00	.00
SILVER BOW CREEK BELOW CONFLUENCE WITH BLACKTAIL CR. (@ MT ST)																	
TM-01	6/12/1992	07:30	N/A	N/A	440	7.1	N/A	19.5	724	7.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	6/19/1992	09:43	10.4	4680	387	7.6	239.7	13.3	404	7.8	3.64	20.01	3682.88	.00	.42	.00	17.83
	8/20/1992	11:50	15.4	6930	377	6.7	-14.2	13.4	394	7.4	7.06	41.09	6665.38	5.81	.36	25.81	104.67
MISSOULA GULCH (@ CENTENNIAL AVE.)																	
TM-02	6/11/1992	17:45	N/A	N/A	510	7.4	N/A	18.0	561	7.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	6/20/1992	11:00	.6	251	424	6.1	13.1	14.1	458	7.1	.02	12.78	508.09	.13	.00	1.58	25.61
SILVER BOW CREEK BELOW COLORADO TAILINGS (@ USGS GAGE)																	
SS-07	6/12/1992	08:00	19.0	8550	480	7.2	N/A	17.9	548	7.2	31.75	161.81	12238.00	.00	2.36	32.98	214.04
	6/19/1992	12:55	20.0	9000	605	7.1	309.7	19.5	530	7.4	17.36	134.75	11060.28	.00	1.37	20.70	174.64
	8/21/1992	09:45	17.0	7650	400	7.1	-21.5	15.9	540	7.4	12.00	87.69	8732.34	.00	1.04	8.61	86.32

N/A - NOT ANALYZED

APPENDIX B

DOWNGRADIENT MONITORING WELL DATA

ENERGY LABORATORIES

ENERGY LABORATORIES, INC.
P.O. BOX 30916 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489

Client: Pioneer Technical Services
Date Sampled: 10-APR-95 08:00
Date Received: 11-APR-95
Analysis Date: 12-APR-1995 23:34
File: /chem/5971A.i/va041295.b/apr122101021.d
Project Info: BSB Landfill
Sample Info: CR-1

Lab No.: 95-26190
Report Date: 04/14/95
Extraction Method: EPA 5030
Sample Matrix: WATER

Crematorium

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
Acetone	67-64-1	<50	U
Acrylonitrile	107-13-1	<20	U
Benzene	71-43-2	<1.0	U
Bromochloromethane	74-97-5	<1.0	U
Bromodichloromethane	75-27-4	<1.0	U
Bromoform	75-25-2	<1.0	U
Bromomethane	74-83-9	<1.0	U*
Carbon disulfide	75-15-0	<1.0	U
Carbon tetrachloride	56-23-5	<1.0	U
Chlorobenzene	108-90-7	<1.0	U
Chloroethane	75-00-3	<1.0	U
Chloroform	67-66-3	<1.0	U
Chloromethane	74-87-3	1.6	
Dibromochloromethane	124-48-1	<1.0	U
1,2-Dibromo-3-chloropropane	96-12-8	<1.0	U
1,2-Dibromoethane	106-93-4	<1.0	U
Dibromomethane	74-95-3	<1.0	U
1,2-Dichlorobenzene	95-50-1	<1.0	U
1,4-Dichlorobenzene	106-46-7	<1.0	U
trans-1,4-Dichloro-2-butene	110-57-6	<2.0	U
Dichlorodifluoromethane	75-71-8	<1.0	U
1,1-Dichloroethane	75-34-3	<1.0	U
1,2-Dichloroethane	107-06-2	<1.0	0.65J
1,1-Dichloroethene	75-35-4	<1.0	U
cis-1,2-Dichloroethene	156-59-2	<1.0	U
trans-1,2-Dichloroethene	156-60-5	<1.0	U
1,2-Dichloropropane	78-87-5	<1.0	U
cis-1,3-Dichloropropene	10061-01-5	<1.0	U
trans-1,3-Dichloropropene	10061-02-6	<1.0	U
Ethyl benzene	100-41-4	<1.0	U
2-Hexanone	591-78-6	<20	U
Iodomethane	74-88-4	<1.0	U
Methyl ethyl ketone	78-93-3	<20	U
Methyl isobutyl ketone	108-10-1	<20	U
Methylene chloride	75-09-2	<1.0	U
Styrene	100-42-5	<1.0	U
1,1,1,2-Tetrachloroethane	630-20-6	<1.0	U
1,1,2,2-Tetrachloroethane	79-34-5	<1.0	U
Tetrachloroethene	127-18-4	<1.0	U
Toluene	108-88-3	<1.0	U
1,1,1-Trichloroethane	71-55-6	<1.0	U

(report continued on page 2)

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT (continued)

Crematorium

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
1,1,2-Trichloroethane	79-00-5	<1.0	U
Trichloroethene	79-01-6	<1.0	U
Trichlorofluoromethane	75-69-4	<1.0	U
1,2,3-Trichloropropane	96-18-4	<1.0	U
Vinyl acetate	108-05-4	<1.0	U
Vinyl chloride	75-01-4	<1.0	U
m+p-Xylenes	108383/106423	<1.0	U
o-Xylene	95-47-6	<1.0	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added ug/L	Measured ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	9.28	93	80--120
Toluene d8	10.0	10.2	102	80--120
p-Bromofluorobenzene	10.0	9.90	99	80--120

QUALIFIER CODES EXPLANATION:

U= Indicates compound was analyzed for but not detected.

J= Estimated value. Present, but less than the limit of quantitation.

*= Compound was analyzed for on April 13,1995 on a second instrument.

REPORT COMMENTS: None

Analyst:________ Reviewing Supervisor:________

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FAX (406) 252-6069 • 1-800-735-4489

Client: Pioneer Technical Services
Date Sampled: 10-APR-95 08:45
Date Received: 11-APR-95
Analysis Date: 13-APR-1995 00:11
File: /chem/5971A.i/va041295.b/apr122201022.d
Project Info: BSB Landfill
Sample Info: CE-2

Lab No.: 95-26191
Report Date: 04/14/95
Extraction Method: EPA 5030
Sample Matrix: WATER

Cemetery - Near Office

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
Acetone	67-64-1	<50	U
Acrylonitrile	107-13-1	<20	U
Benzene	71-43-2	<1.0	U
Bromochloromethane	74-97-5	<1.0	U
Bromodichloromethane	75-27-4	<1.0	U
Bromoform	75-25-2	<1.0	U
Bromomethane	74-83-9	<1.0	U*
Carbon disulfide	75-15-0	<1.0	U
Carbon tetrachloride	56-23-5	<1.0	U
Chlorobenzene	108-90-7	<1.0	U
Chloroethane	75-00-3	<1.0	U
Chloroform	67-66-3	<1.0	0.33J
Chloromethane	74-87-3	2.6	**
Dibromochloromethane	124-48-1	<1.0	U
1,2-Dibromo-3-chloropropane	96-12-8	<1.0	U
1,2-Dibromoethane	106-93-4	<1.0	U
Dibromomethane	74-95-3	<1.0	U
1,2-Dichlorobenzene	95-50-1	<1.0	U
1,4-Dichlorobenzene	106-46-7	<1.0	U
trans-1,4-Dichloro-2-butene	110-57-6	<2.0	U
Dichlorodifluoromethane	75-71-8	<1.0	U
1,1-Dichloroethane	75-34-3	<1.0	U
1,2-Dichloroethane	107-06-2	<1.0	0.74J**
1,1-Dichloroethene	75-35-4	<1.0	U
cis-1,2-Dichloroethene	156-59-2	<1.0	U
trans-1,2-Dichloroethene	156-60-5	<1.0	U
1,2-Dichloropropane	78-87-5	<1.0	U
cis-1,3-Dichloropropene	10061-01-5	<1.0	U
trans-1,3-Dichloropropene	10061-02-6	<1.0	U
Ethyl benzene	100-41-4	<1.0	U
2-Hexanone	591-78-6	<20	U
Iodomethane	74-88-4	<1.0	U
Methyl ethyl ketone	78-93-3	<20	U
Methyl isobutyl ketone	108-10-1	<20	U
Methylene chloride	75-09-2	<1.0	U
Styrene	100-42-5	<1.0	U
1,1,1,2-Tetrachloroethane	630-20-6	<1.0	U
1,1,2,2-Tetrachloroethane	79-34-5	<1.0	U
Tetrachloroethene	127-18-4	<1.0	0.35J
Toluene	108-88-3	<1.0	U
1,1,1-Trichloroethane	71-55-6	<1.0	U

(report continued on page 2)

Lab No.: 95-26191
Sample Info: CE-2

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT (continued)

Cemetery - Nar 07

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
1,1,2-Trichloroethane	79-00-5	<1.0	U
Trichloroethene	79-01-6	<1.0	U
Trichlorofluoromethane	75-69-4	<1.0	U
1,2,3-Trichloropropane	96-18-4	<1.0	U
Vinyl acetate	108-05-4	<1.0	U
Vinyl chloride	75-01-4	<1.0	U
m+p-Xylenes	108383/106423	<1.0	U
o-Xylene	95-47-6	<1.0	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added ug/L	Measured ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	9.38	94	80--120
Toluene d8	10.0	10.2	102	80--120
p-Bromofluorobenzene	10.0	9.73	97	80--120

QUALIFIER CODES EXPLANATION:

U= Indicates compound was analyzed for but not detected.

J= Estimated value. Present, but less than the limit of quantitation.

*= Compound was analyzed for on April 13,1995 on a second instrument.

**= The second analysis performed on this sample on April 13, 1995 yielded a value of 8.2 for chloromethane and 2.1 for 1,2-dichloroethane. The values for the other detected analytes agreed between the two runs. The second run was performed on the second vial of sample.

REPORT COMMENTS: None

Analyst: CHH Reviewing Supervisor: WTB

EPA METHOD 8260 BLANK SPIKE REPORT

Quality Control Sample: Certified Reference Sample Analysis 12-APR-95 21:09
Report Date: 04/13/95
Extraction Method: EPA 5030
Sample Matrix: WATER
File: /chem/5971A.i/va041295.b/apr121701017.d

Remarks: This certified reference sample was spiked into a blank sample matrix then extracted and analyzed with your set of samples to determine if the methodology is in control and to monitor the laboratory's ability to produce accurate results.

CONCENTRATION UNITS = ug/L (ppb)

Spike Compound	Added	Measured	%Rec	QC Limits
Carbon tetrachloride	5.00	4.93	99	60--140
Chlorobenzene	5.00	4.53	91	60--140
1,3-Dichlorobenzene	5.00	4.75	95	60--140
1,4-Dichlorobenzene	5.00	4.56	91	60--140
1,2-Dichloroethane	5.00	4.67	93	60--140
1,1-Dichloroethene	5.00	4.55	91	60--140
trans-1,2-Dichloroethene	5.00	4.47	89	60--140
1,2-Dichloropropane	5.00	4.50	90	60--140
Ethyl benzene	5.00	4.80	96	60--140
Tetrachloroethene	5.00	4.48	90	60--140
1,1,2-Trichloroethane	5.00	4.76	95	60--140

SURROGATE RECOVERY REPORT

Surrogate Compound	Added ug/L	Measured ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	10.2	102	80--120
Toluene d8	10.0	8.68	87	80--120
p-Bromofluorobenzene	10.0	10.2	102	80--120

REPORT COMMENTS: None

Analyst:________ Reviewing Supervisor:________

Quality Control Sample: Laboratory Reagent Blank 12-APR-95 21:45
Report Date: 04/13/95
Extraction Method: EPA 5030
Sample Matrix: WATER
File: /chem/5971A.i/va041295.b/apr121801018.d
Remarks: This Laboratory Reagent Blank Quality Control Sample was extracted and analyzed with your set of samples to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
Acetone	67-64-1	<50	U
Acrylonitrile	107-13-1	<20	U
Benzene	71-43-2	<1.0	U
Bromochloromethane	74-97-5	<1.0	U
Bromodichloromethane	75-27-4	<1.0	U
Bromoform	75-25-2	<1.0	U
Bromomethane	74-83-9	<1.0	U
Carbon disulfide	75-15-0	<1.0	U
Carbon tetrachloride	56-23-5	<1.0	U
Chlorobenzene	108-90-7	<1.0	U
Chloroethane	75-00-3	<1.0	U
Chloroform	67-66-3	<1.0	U
Chloromethane	74-87-3	<1.0	U
Dibromochloromethane	124-48-1	<1.0	U
1,2-Dibromo-3-chloropropane	96-12-8	<1.0	U
1,2-Dibromoethane	106-93-4	<1.0	U
Dibromomethane	74-95-3	<1.0	U
1,2-Dichlorobenzene	95-50-1	<1.0	U
1,4-Dichlorobenzene	106-46-7	<1.0	U
trans-1,4-Dichloro-2-butene	110-57-6	<2.0	U
Dichlorodifluoromethane	75-71-8	<1.0	U
1,1-Dichloroethane	75-34-3	<1.0	U
1,2-Dichloroethane	107-06-2	<1.0	U
1,1-Dichloroethene	75-35-4	<1.0	U
cis-1,2-Dichloroethene	156-59-2	<1.0	U
trans-1,2-Dichloroethene	156-60-5	<1.0	U
1,2-Dichloropropane	78-87-5	<1.0	U
cis-1,3-Dichloropropene	10061-01-5	<1.0	U
trans-1,3-Dichloropropene	10061-02-6	<1.0	U
Ethyl benzene	100-41-4	<1.0	U
2-Hexanone	591-78-6	<20	U
Iodomethane	74-88-4	<1.0	U
Methyl ethyl ketone	78-93-3	<20	U
Methyl isobutyl ketone	108-10-1	<20	U
Methylene chloride	75-09-2	<1.0	U
Styrene	100-42-5	<1.0	U
1,1,1,2-Tetrachloroethane	630-20-6	<1.0	U
1,1,2,2-Tetrachloroethane	79-34-5	<1.0	U
Tetrachloroethene	127-18-4	<1.0	U
Toluene	108-88-3	<1.0	U
1,1,1-Trichloroethane	71-55-6	<1.0	U

(report continued on page 2)

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT (continued)

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
1,1,2-Trichloroethane	79-00-5	<1.0	U
Trichloroethene	79-01-6	<1.0	U
Trichlorofluoromethane	75-69-4	<1.0	U
1,2,3-Trichloropropane	96-18-4	<1.0	U
Vinyl acetate	108-05-4	<1.0	U
Vinyl chloride	75-01-4	<1.0	U
m+p-Xylenes	108383/106423	<1.0	U
o-Xylene	95-47-6	<1.0	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added ug/L	Measured ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	9.29	93	80--120
Toluene d8	10.0	9.63	96	80--120
p-Bromofluorobenzene	10.0	10.4	104	80--120

QUALIFIER CODES EXPLANATION:

U= Indicates compound was analyzed for but not detected.

REPORT COMMENTS: None

Analyst: CHW Reviewing Supervisor: ____

Lab Nos. 95-26190-91

Date 04/11/95

Received by Pam Fink

SAMPLE CONDITION QA/QC REPORT

This report provides information about the condition of the sample(s) and associated sample custody information on receipt at the laboratory.

Chain-of-custody form completed & signed	Yes	Comments:
Chain-of-custody seal properly placed	Yes	Comments:
Chain of custody seal intact	Yes	Comments:
Signature Match, Chain-of-custody vs. Seal	Yes	Comments:
Sample received cold	Yes	Comments:
Samples received within holding time	Yes	Comments:
Samples received in proper containers and properly preserved	Yes	Comments:
Client notified about sample discrepancies		Comments:

Who:__________ By:__________ Date/Time:__________

Method of Shipment: UPS

ENERGY LABORATORIES, INC.
P.O. Box 30916 *1107 South Broadway*
Billings, MT 59107
toll-free *800-735-4489*
voice *406-252-6325*
fax *406-252-6069*

CHAIN OF CUSTODY RECORD

PLEASE PRINT OR TYPE ALL INFORMATION EXCEPT SIGNATURES

P.O. #

Project Name / Address BSB Landfill

Contact Name & Phone Shawn Bisch 782-5177

Sampler's signature Shawn Bisch

Invoice to:
Marc Murphy
P.O. Box 3445
Butte, MT 59702

Report to:
Shawn Bisch
P.O. Box 3445
Butte, MT 59702

DATE	*TIME*	*composite*	*grab sample*	SAMPLE I.D.	*number of containers*	*Sample Type: A W S V U O* *Air Water Soils/solids Vegetation Urine Other*	*Analysis Requested* VOC's 8260 Table I								**Comments, Special Instructions, etc.**
4/10/95	800		X	CR-1	2	W	X								Results promised for Friday 4/14 at no additional Cost.
4/10/95	845		X	CE-2	2	W	X								

1. *Relinquished (signature)*	*Date*	*Time*	*Received by: (signature)*	3. *Relinquished (signature)*	*Date*	*Time*	*Received by (signature):*
Shawn Bisch	4/10/95	1630					
2. *Relinquished (signature)*	*Date*	*Time*	*Received by: (signature)*	4. *Relinquished (signature)*	*Date*	*Time*	*Received for laboratory by (signature):*
					04/11/95	1319	Pam Fink

ENERGY LABORATORIES

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Client: Pioneer Technical Services
Date Sampled: 21-APR-95 10:00
Date Received: 24-APR-95
Analysis Date: 25-APR-1995 15:18
File: /chem/5971A.i/va042595.b/apr251101011.d
Project Info: Proj. Code 9503, BSB Landfill
Sample Info: BL-4

BLANKENSHIP

Lab No.: 95-27119
Report Date: 04/25/95
Extraction Method: EPA 5030
Sample Matrix: WATER

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
Acetone	67-64-1	<50	U
Acetonitrile	75-05-8	<20	U
Acrolein	107-02-8	<20	U
Acrylonitrile	107-13-1	<20	U
Allyl chloride	107-05-1	<1.0	U
Benzene	71-43-2	<1.0	U
Bromochloromethane	74-97-5	<1.0	U
Bromodichloromethane	75-27-4	<1.0	U
Bromoform	75-25-2	<1.0	U
Bromomethane	74-83-9	<1.0	U*
Isobutanol	78-83-1	<50	U
Carbon disulfide	75-15-0	<1.0	U
Carbon tetrachloride	56-23-5	<1.0	U
Chlorobenzene	108-90-7	<1.0	U
Chloroethane	75-00-3	<1.0	U
Chloroform	67-66-3	<1.0	U
Chloromethane	**74-87-3**	**3.0**	
Chloroprene	126-99-8	<1.0	U
Dibromochloromethane	124-48-1	<1.0	U
1,2-Dibromo-3-chloropropane	96-12-8	<1.0	U
1,2-Dibromoethane	106-93-4	<1.0	U
Dibromomethane	74-95-3	<1.0	U
1,2-Dichlorobenzene	95-50-1	<1.0	U
1,3-Dichlorobenzene	541-73-1	<1.0	U
1,4-Dichlorobenzene	106-46-7	<1.0	U
trans-1,4-Dichloro-2-butene	110-57-6	<2.0	U
Dichlorodifluoromethane	75-71-8	<1.0	U
1,1-Dichloroethane	75-34-3	<1.0	U
1,2-Dichloroethane	**107-06-2**	**1.2**	
1,1-Dichloroethene	75-35-4	<1.0	U
cis-1,2-Dichloroethene	156-59-2	<1.0	U
trans-1,2-Dichloroethene	156-60-5	<1.0	U
1,2-Dichloropropane	78-87-5	<1.0	U
1,3-Dichloropropane	142-28-9	<1.0	U
2,2-Dichloropropane	594-20-7	<1.0	U
1,1-Dichloropropene	563-58-6	<1.0	U
cis-1,3-Dichloropropene	10061-01-5	<1.0	U
trans-1,3-Dichloropropene	10061-02-6	<1.0	U
Ethyl benzene	100-41-4	<1.0	U
Ethyl methacrylate	97-63-2	<1.0	U
Hexachlorobutadiene	87-68-3	<1.0	U

(report continued on page 2)

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT (continued)

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
2-Hexanone	591-78-6	<20	U
Iodomethane	74-88-4	<1.0	U
Methacrylonitrile	126-98-7	<20	U
Methyl ethyl ketone	78-93-3	<20	U
Methyl isobutyl ketone	108-10-1	<20	U
Methyl methacrylate	80-62-6	<1.0	U
Methylene chloride	75-09-2	<1.0	U
Naphthalene	91-20-3	<1.0	U
Pentachloroethane	76-01-7	<2.0	U
Propionitrile	107-12-0	<20	U
Styrene	100-42-5	<1.0	U
1,1,1,2-Tetrachloroethane	630-20-6	<1.0	U
1,1,2,2-Tetrachloroethane	79-34-5	<1.0	U
Tetrachloroethene	127-18-4	<1.0	U
Toluene	108-88-3	<1.0	U
1,2,4-Trichlorobenzene	120-82-1	<1.0	U
1,1,1-Trichloroethane	71-55-6	<1.0	U
1,1,2-Trichloroethane	79-00-5	<1.0	U
Trichloroethene	79-01-6	<1.0	U
Trichlorofluoromethane	75-69-4	<1.0	U
1,2,3-Trichloropropane	96-18-4	<1.0	U
Vinyl acetate	108-05-4	<1.0	U
Vinyl chloride	75-01-4	<1.0	U
m+p-Xylenes	108383/106423	<1.0	U
o-Xylene	95-47-6	<1.0	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added ug/L	Measured ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	9.18	92	80--120
Toluene d8	10.0	9.66	97	80--120
p-Bromofluorobenzene	10.0	9.71	97	80--120

QUALIFIER CODES EXPLANATION:

U= Indicates compound was analyzed for but not detected.

*= Bromomethane was analyzed May 03, 1995.

REPORT COMMENTS:

Analyst: CHH WD Reviewing Supervisor: WTB

EPA METHOD 8260 BLANK SPIKE REPORT

Quality Control Sample: Certified Reference Sample Analysis 25-APR-95 10:13
Report Date: 04/25/95
Extraction Method: EPA 5030
Sample Matrix: WATER
File: /chem/5971A.i/va042595.b/apr250301003.d

Remarks: This certified reference sample was spiked into a blank sample matrix then extracted and analyzed with your set of samples to determine if the methodology is in control and to monitor the laboratory's ability to produce accurate results.

CONCENTRATION UNITS = ug/L (ppb)

Spike Compound	Added	Measured	%Rec	QC Limits
Carbon tetrachloride	5.00	5.28	106	60--140
Chlorobenzene	5.00	5.00	100	60--140
1,3-Dichlorobenzene	5.00	5.34	107	60--140
1,4-Dichlorobenzene	5.00	5.15	103	60--140
1,2-Dichloroethane	5.00	4.78	96	60--140
1,1-Dichloroethene	5.00	4.76	95	60--140
trans-1,2-Dichloroethene	5.00	4.98	100	60--140
1,2-Dichloropropane	5.00	4.57	91	60--140
Ethyl benzene	5.00	5.36	107	60--140
Tetrachloroethene	5.00	5.08	102	60--140
1,1,2-Trichloroethane	5.00	4.90	98	60--140

SURROGATE RECOVERY REPORT

Surrogate Compound	Added ug/L	Measured ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	10.3	103	80--120
Toluene d8	10.0	9.96	100	80--120
p-Bromofluorobenzene	10.0	10.0	100	80--120

REPORT COMMENTS: None

Analyst: ________ Reviewing Supervisor: ________

Quality Control Sample: Laboratory Reagent Blank 25-APR-95 14:40
Report Date: 04/25/95
Extraction Method: EPA 5030
Sample Matrix: WATER
File: /chem/5971A.i/va042595.b/apr251001010.d
Remarks: This Laboratory Reagent Blank Quality Control Sample was extracted and analyzed with your set of samples to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
Acetone	67-64-1	<50	U
Acetonitrile	75-05-8	<20	U
Acrolein	107-02-8	<20	U
Acrylonitrile	107-13-1	<20	U
Allyl chloride	107-05-1	<1.0	U
Benzene	71-43-2	<1.0	U
Bromochloromethane	74-97-5	<1.0	U
Bromodichloromethane	75-27-4	<1.0	U
Bromoform	75-25-2	<1.0	U
Bromomethane	74-83-9	<1.0	U
Isobutanol	78-83-1	<50	U
Carbon disulfide	75-15-0	<1.0	U
Carbon tetrachloride	56-23-5	<1.0	U
Chlorobenzene	108-90-7	<1.0	U
Chloroethane	75-00-3	<1.0	U
Chloroform	67-66-3	<1.0	U
Chloromethane	74-87-3	<1.0	U
Chloroprene	126-99-8	<1.0	U
Dibromochloromethane	124-48-1	<1.0	U
1,2-Dibromo-3-chloropropane	96-12-8	<1.0	U
1,2-Dibromoethane	106-93-4	<1.0	U
Dibromomethane	74-95-3	<1.0	U
1,2-Dichlorobenzene	95-50-1	<1.0	U
1,3-Dichlorobenzene	541-73-1	<1.0	U
1,4-Dichlorobenzene	106-46-7	<1.0	U
trans-1,4-Dichloro-2-butene	110-57-6	<2.0	U
Dichlorodifluoromethane	75-71-8	<1.0	U
1,1-Dichloroethane	75-34-3	<1.0	U
1,2-Dichloroethane	107-06-2	<1.0	U
1,1-Dichloroethene	75-35-4	<1.0	U
cis-1,2-Dichloroethene	156-59-2	<1.0	U
trans-1,2-Dichloroethene	156-60-5	<1.0	U
1,2-Dichloropropane	78-87-5	<1.0	U
1,3-Dichloropropane	142-28-9	<1.0	U
2,2-Dichloropropane	594-20-7	<1.0	U
1,1-Dichloropropene	563-58-6	<1.0	U
cis-1,3-Dichloropropene	10061-01-5	<1.0	U
trans-1,3-Dichloropropene	10061-02-6	<1.0	U
Ethyl benzene	100-41-4	<1.0	U
Ethyl methacrylate	97-63-2	<1.0	U
Hexachlorobutadiene	87-68-3	<1.0	U

(report continued on page 2)

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT (continued)

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
2-Hexanone	591-78-6	<20	U
Iodomethane	74-88-4	<1.0	U
Methacrylonitrile	126-98-7	<20	U
Methyl ethyl ketone	78-93-3	<20	U
Methyl isobutyl ketone	108-10-1	<20	U
Methyl methacrylate	80-62-6	<1.0	U
Methylene chloride	75-09-2	<1.0	U
Naphthalene	91-20-3	<1.0	U
Pentachloroethane	76-01-7	<2.0	U
Propionitrile	107-12-0	<20	U
Styrene	100-42-5	<1.0	U
1,1,1,2-Tetrachloroethane	630-20-6	<1.0	U
1,1,2,2-Tetrachloroethane	79-34-5	<1.0	U
Tetrachloroethene	127-18-4	<1.0	U
Toluene	108-88-3	<1.0	U
1,2,4-Trichlorobenzene	120-82-1	<1.0	U
1,1,1-Trichloroethane	71-55-6	<1.0	U
1,1,2-Trichloroethane	79-00-5	<1.0	U
Trichloroethene	79-01-6	<1.0	U
Trichlorofluoromethane	75-69-4	<1.0	U
1,2,3-Trichloropropane	96-18-4	<1.0	U
Vinyl acetate	108-05-4	<1.0	U
Vinyl chloride	75-01-4	<1.0	U
m+p-Xylenes	108383/106423	<1.0	U
o-Xylene	95-47-6	<1.0	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added ug/L	Measured ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	10.0	100	80--120
Toluene d8	10.0	9.81	98	80--120
p-Bromofluorobenzene	10.0	10.3	103	80--120

QUALIFIER CODES EXPLANATION:

U= Indicates compound was analyzed for but not detected.

REPORT COMMENTS: None

Analyst: CLH Reviewing Supervisor:

Lab Nos. 95-27119

Date 04/24/95

Received by Randa Hoelscher

SAMPLE CONDITION QA/QC REPORT

This report provides information about the condition of the sample(s) and associated sample custody information on receipt at the laboratory.

Chain-of-custody form completed & signed	Yes	Comments:
Chain-of-custody seal properly placed	Yes	Comments:
Chain-of-custody seal intact	Yes	Comments:
Signature Match, Chain-of-custody vs. Seal	Yes	Comments:
Sample received cold	Yes	Comments:
Samples received within holding time	Yes	Comments:
Samples received in proper containers and properly preserved	Yes	Comments:
Client notified about sample discrepancies		Comments:

Who: By: Date/Time:

Method of Shipment UPS

CHAIN OF CUSTODY

PROJECT CODE	PROJECT NAME
9503	BSB Landfill

SAMPLERS (SIGNATURE) Shaun Bisch 782-5177 Shaun Bisch

ANALYSIS REQUESTED

SAMPLE INDENTIFICATION	SAMPLED DATE	SAMPLED TIME	VOC's 8260 (Tbl. II)								REMARKS
BL-4	4/21/95	1000	X								

RELINQUISHED BY (SIGN.)	DATE TIME	RECIEVED BY (SIGN.)	RELINQUISHED BY (SIGN.)	DATE TIME	RECIEVED BY (SIGN.)
Shaun Bisch	4/24/95 1500				

RELINQUISHED BY (SIGN.)	DATE TIME	RECIEVED BY (SIGN.)	RELINQUISHED BY (SIGN.)	DATE TIME	RECIEVED BY (SIGN.)

RELINQUISHED BY (SIGN.)	DATE TIME	RECIEVED FOR LAB (SIGN.)	DATE TIME
		Landa Hoelscher	04/24/95@1305

REMARKS

PIONEER
TECHNICAL SERVICES, INC.
P.O. BOX 3445
BUTTE, MT 59701
PHONE: (406)-782-5177
FAX: (406)-782-5866

MSE
A Subsidiary of MTC
MSE, Inc. Corporate Office P.O. Box 4078 Butte, MT 59702 (406) 723-8213 FAX (406) 723-8328
Western Environmental Technology Office (WETO) Butte, MT 59702 (406) 494-7100 FAX (406) 494-7230

April 20, 1995

95MSE283

Shawn Bisch
Pioneer Technical Services, Inc.
P.O. Box 3445
Butte, MT 59701

Dear Shawn:

Please find enclosed analytical results for the water sample received at the MSE Laboratory April 10, 1995.

If you have any questions, please do not hesitate to call.

Sincerely,

Kevin Kissell

Kevin Kissell
Laboratory Supervisor

KK/rbk

Enclosure

CLIENT: Pioneer Technical Services-BSB Landfill Report Date: 4/19/95 Page 1
FIELD ID: RE-3
LAB ID: W004019
DATE/TIME SAMPLED: 04/10/95 10:00:0
DATE RECEIVED: 4/10/95
BIF: 000468

REAP

METALS DISSOLVED

Antimony		0.009	mg/L
Arsenic		0.002	mg/L
Barium		0.017	mg/L
Beryllium		0.0003	mg/L
Cadmium		0.0002	mg/L
Chromium	<	0.009	mg/L
Cobalt	<	0.01	mg/L
Copper	<	0.002	mg/L
Iron		10.7	mg/L
Lead		0.003	mg/L
Mercury	<	0.0001	mg/L
Nickel		0.01	mg/L
Selenium	<	0.001	mg/L
Silver	<	0.001	mg/L
Thallium		0.003	mg/L
Vanadium		0.006	mg/L
Zinc		0.073	mg/L

GFW
Review

CLIENT: Pioneer Technical Services-BSB Landfill **Report Date: 4/27/95** **Page 1**
FIELD ID: BL-4
LAB ID: W004097
DATE/TIME SAMPLED: 04/21/95 13:00:0
DATE RECEIVED: 4/21/95
BIF: 000495

Blancenship

METALS DISSOLVED

Antimony	<	0.002	mg/L
Arsenic		0.002	mg/L
Barium		0.090	mg/L
Beryllium	<	0.0001	mg/L
Cadmium	<	0.0001	mg/L
Chromium	<	0.009	mg/L
Cobalt	<	0.01	mg/L
Copper		0.016	mg/L
Iron		0.088	mg/L
Lead	<	0.001	mg/L
Mercury	<	0.0001	mg/L
Nickel	<	0.01	mg/L
Selenium	<	0.001	mg/L
Silver	<	0.001	mg/L
Thallium	<	0.001	mg/L
Vanadium		0.006	mg/L
Zinc		0.539	mg/L

Review

MSE,INC.
CHAIN OF CUSTODY

Project Code 9503	**Project Name** BSB Landfill

SAMPLERS (Signature)

SAMPLE IDENTIFICATION	SAMPLED		ANALYSIS REQUESTED									Remarks
	DATE	TIME	Metals									
BL-4	4/21/95	1000	X									Rush

Relinquished by (Sign.)	**Date** 4/21/95	**Time** 1250	**Received by (Sign.)**	**Remarks** Rush
Relinquished by (Sign.)	**Date**	**Time**	**Received by (Sign.)**	
Relinquished by (Sign.)	**Date Time**	**Recieved for Lab by (Sign.)**	**Date Time** 4-21-95 1350	

MSE, INC.
P.O. Box 4078
220 N. Alaska
Butte, MT 59702

PHONE: (800) 441-8213
FAX: (406) 723-8328

ACAD#: 1300-001
REV: B DATE: 6/9/93
DRAFTER: DB

APPENDIX C

HELP MODELING RESULTS

```
******************************************************************************

******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.01  (14 OCTOBER 1994)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                          **
**                                                                          **
******************************************************************************

******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\DATA4.D4
TEMPERATURE DATA FILE:      C:\HELP3\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\BUTTEA3.D10
OUTPUT DATA FILE:           C:\HELP3\BUTTEA3.OUT


TIME: 13:29   DATE:  4/27/1995


******************************************************************************

  TITLE:  BUTTE LANDFILL, EXISTING CONDITIONS

******************************************************************************
```

```
    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE
          COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                          LAYER  1
                          --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  4
         THICKNESS                   =     12.00   INCHES
         POROSITY                    =     0.4370 VOL/VOL
         FIELD CAPACITY              =     0.1050 VOL/VOL
         WILTING POINT               =     0.0470 VOL/VOL
         INITIAL SOIL WATER CONTENT  =     0.0741 VOL/VOL
         EFFECTIVE SAT. HYD. COND.   = 0.170000002000E-02 CM/SEC
       NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
              FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                          LAYER  2
                          --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  18
         THICKNESS                   =    180.00   INCHES
         POROSITY                    =     0.6710 VOL/VOL
         FIELD CAPACITY              =     0.2920 VOL/VOL
         WILTING POINT               =     0.0770 VOL/VOL
         INITIAL SOIL WATER CONTENT  =     0.2476 VOL/VOL
         EFFECTIVE SAT. HYD. COND.   = 0.100000005000E-02 CM/SEC


              GENERAL DESIGN AND EVAPORATIVE ZONE DATA
              ----------------------------------------

       NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
              SPECIFIED CURVE NUMBER OF 79.0, A SURFACE SLOPE
              OF  4.% AND A SLOPE LENGTH OF 2250. FEET.
```

```
   SCS RUNOFF CURVE NUMBER             =  77.20
   FRACTION OF AREA ALLOWING RUNOFF    =    100.0   PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =    69.000  ACRES
   EVAPORATIVE ZONE DEPTH          =    7.8    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =   0.363  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =     3.409  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =     0.367  INCHES
   INITIAL SNOW WATER              =    0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS   =    45.450  INCHES
   TOTAL INITIAL WATER             =   45.450  INCHES
   TOTAL SUBSURFACE INFLOW           =      0.00   INCHES/YEAR


          EVAPOTRANSPIRATION AND WEATHER DATA
          -----------------------------------

   NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         Butte            Montana

     MAXIMUM LEAF AREA INDEX                 = 1.00
     START OF GROWING SEASON (JULIAN DATE) =  138
     END OF GROWING SEASON (JULIAN DATE)    =  266
     AVERAGE ANNUAL WIND SPEED                  = 7.80 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 63.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY  = 54.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 49.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY  = 63.00 %


   NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR    HELENA            MONTANA

         NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

 JAN/JUL   FEB/AUG   MAR/SEP   APR/OCT   MAY/NOV   JUN/DEC
 -------   -------   -------   -------   -------   -------
  0.60      0.40      0.80      1.00      2.10      2.40
  1.30      1.30      1.20      0.80      0.60      0.60


   NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
```

```
          COEFFICIENTS FOR     HELENA            MONTANA

        NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

   JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
   -------     -------     -------     -------     -------     -------
    18.00       24.00       27.00       37.00       47.00       54.00
    61.00       60.00       51.00       41.00       29.00       22.00


      NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
             COEFFICIENTS FOR     HELENA            MONTANA

                 STATION LATITUDE  = 45.59 DEGREES



*******************************************************************************
*

      AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH  100
------------------------------------------------------------------------------

                 JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                 -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS           0.62     0.36     0.88     1.02     2.12     2.43
                 1.34     1.25     1.25     0.85     0.59     0.58

    STD. DEVIATIONS      0.34     0.24     0.47     0.54     0.93     1.17
                 0.78     0.67     0.84     0.52     0.32     0.31

  RUNOFF
  ------
    TOTALS            0.023    0.016    0.063    0.078    0.072    0.001
                 0.000    0.000    0.000    0.000    0.004    0.005

    STD. DEVIATIONS       0.096    0.051    0.120    0.118    0.251    0.010
                 0.000    0.000    0.000    0.000    0.017    0.015
  EVAPOTRANSPIRATION
  ------------------
   TOTALS             0.484   0.486   0.654   0.791   1.704   2.182
                 1.338   1.218   1.178   0.668   0.525   0.465

   STD. DEVIATIONS       0.152   0.220   0.226   0.395   0.704   0.896
                 0.755   0.605   0.688   0.404   0.233   0.152

  PERCOLATION/LEAKAGE THROUGH LAYER  2
  ------------------------------------
   TOTALS             0.1307  0.1183  0.1279  0.1209  0.1328  0.1342
                 0.0962  0.0642  0.0885  0.1233  0.1172  0.1215

   STD. DEVIATIONS       0.0419  0.0321  0.0332  0.0303  0.0348  0.0339
                 0.0462  0.0531  0.0629  0.0453  0.0486  0.0393

*****************************************************************************
*


*****************************************************************************
*

   AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH
100
 ------------------------------------------------------------------------
                         INCHES          CU. FEET      PERCENT
                     -------------------  -------------  ---------
 PRECIPITATION              13.28   (  2.345)   3326292.5     100.00

 RUNOFF                  0.264   ( 0.3280)    66048.06      1.986

 EVAPOTRANSPIRATION            11.692   ( 1.9325)   2928412.00     88.038

 PERCOLATION/LEAKAGE THROUGH     1.37561 (  0.35764)    344549.094    10.35835
   FROM LAYER  2

 CHANGE IN WATER STORAGE        -0.051   ( 0.8691)    -12717.03     -0.382


*****************************************************************************
```

```
***********************************************************************

       PEAK DAILY VALUES FOR YEARS   1 THROUGH  100
-------------------------------------------------------------------
                            (INCHES)    (CU. FT.)
                            ----------  -------------
   PRECIPITATION                        1.94       485911.812

   RUNOFF                            1.424      356609.0940

   PERCOLATION/LEAKAGE THROUGH LAYER 2     0.016782      4203.33643

   SNOW WATER                           1.81       453353.5000

   MAXIMUM VEG. SOIL WATER (VOL/VOL)              0.2750

   MINIMUM VEG. SOIL WATER (VOL/VOL)             0.0198

***********************************************************************
```

```
*******************************************************************************

        FINAL WATER STORAGE AT END OF YEAR  100
  ----------------------------------------------------------------------

        LAYER       (INCHES)       (VOL/VOL)
        -----       --------       ---------
          1          1.1514          0.0959

          2         39.2216          0.2179

       SNOW WATER          0.000

*******************************************************************************

*******************************************************************************
```

```
******************************************************************************

******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                  **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                **
**                                                                          **
**                                                                          **
******************************************************************************

******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\DATA4.D4
TEMPERATURE DATA FILE:      C:\HELP3\DATA7.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\DATA13.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\DATA11.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\BUTTEA2.D10
OUTPUT DATA FILE:           C:\HELP3\BUTTEA2.OUT


TIME: 13:24    DATE:  4/27/1995



******************************************************************************

  TITLE: CLARK TAILINGS, EXISTING CONDITIONS

******************************************************************************
```

```
      NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE
             COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                          LAYER  1
                          --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   4
          THICKNESS                  =     6.00   INCHES
          POROSITY                   =     0.4370 VOL/VOL
          FIELD CAPACITY             =     0.1050 VOL/VOL
          WILTING POINT              =     0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.0584 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  = 0.170000002000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                          LAYER  2
                          --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  27
          THICKNESS                  =   240.00   INCHES
          POROSITY                   =     0.4000 VOL/VOL
          FIELD CAPACITY             =     0.3660 VOL/VOL
          WILTING POINT              =     0.2880 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.3657 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  = 0.779999993000E-06 CM/SEC


               GENERAL DESIGN AND EVAPORATIVE ZONE DATA
               ----------------------------------------

        NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
               SPECIFIED CURVE NUMBER OF 79.0, A SURFACE SLOPE
               OF 3.% AND A SLOPE LENGTH OF 2250. FEET.
```

```
SCS RUNOFF CURVE NUMBER              =   77.00
FRACTION OF AREA ALLOWING RUNOFF     =   100.0   PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =   60.000  ACRES
EVAPORATIVE ZONE DEPTH               =   7.8     INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =   0.794   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =   3.342   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =   0.800   INCHES
INITIAL SNOW WATER                   =   0.000   INCHES
INITIAL WATER IN LAYER MATERIALS     =   88.113  INCHES
TOTAL INITIAL WATER                  =   88.113  INCHES
TOTAL SUBSURFACE INFLOW              =   0.00    INCHES/YEAR


        EVAPOTRANSPIRATION AND WEATHER DATA
        -----------------------------------

NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
       Butte          Montana

   MAXIMUM LEAF AREA INDEX                    = 1.00
   START OF GROWING SEASON (JULIAN DATE)      = 138
   END OF GROWING SEASON (JULIAN DATE)        = 266
   AVERAGE ANNUAL WIND SPEED                  = 7.80 MPH
   AVERAGE 1ST QUARTER RELATIVE HUMIDITY  = 63.00 %
   AVERAGE 2ND QUARTER RELATIVE HUMIDITY  = 54.00 %
   AVERAGE 3RD QUARTER RELATIVE HUMIDITY  = 49.00 %
   AVERAGE 4TH QUARTER RELATIVE HUMIDITY  = 63.00 %


NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR    HELENA        MONTANA

       NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL    FEB/AUG    MAR/SEP    APR/OCT    MAY/NOV    JUN/DEC
-------    -------    -------    -------    -------    -------
 0.60       0.40       0.80       1.00       2.10       2.40
 1.30       1.30       1.20       0.80       0.60       0.60


NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
```

```
        COEFFICIENTS FOR    HELENA          MONTANA

      NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

   JAN/JUL    FEB/AUG    MAR/SEP    APR/OCT    MAY/NOV    JUN/DEC
   -------    -------    -------    -------    -------    -------
    18.00      24.00      27.00      37.00      47.00      54.00
    61.00      60.00      51.00      41.00      29.00      22.00


   NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
          COEFFICIENTS FOR    HELENA          MONTANA

          STATION LATITUDE  = 45.59 DEGREES



******************************************************************************
*

   AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH  100
 ----------------------------------------------------------------------------

                   JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                   -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
  TOTALS             0.62     0.36     0.88     1.02     2.12     2.43
                     1.34     1.25     1.25     0.85     0.59     0.58

  STD. DEVIATIONS    0.34     0.24     0.47     0.54     0.93     1.17
                     0.78     0.67     0.84     0.52     0.32     0.31

 RUNOFF
 ------
  TOTALS            0.023    0.016    0.064    0.078    0.072    0.005
                    0.000    0.000    0.000    0.000    0.004    0.005

  STD. DEVIATIONS   0.096    0.051    0.121    0.116    0.249    0.033
                    0.000    0.000    0.000    0.000    0.016    0.015
 EVAPOTRANSPIRATION
 ------------------
   TOTALS            0.479   0.487   0.654   0.781   1.757   2.234
                     1.434   1.248   1.210   0.680   0.523   0.457

   STD. DEVIATIONS   0.148   0.224   0.230   0.394   0.717   0.900
                     0.807   0.616   0.729   0.417   0.232   0.155

 PERCOLATION/LEAKAGE THROUGH LAYER  2
 ------------------------------------
   TOTALS            0.1137  0.1082  0.1177  0.1090  0.1156  0.0857
                     0.0497  0.0284  0.0452  0.0812  0.0983  0.1031

   STD. DEVIATIONS   0.0411  0.0306  0.0311  0.0292  0.0326  0.0257
                     0.0216  0.0257  0.0456  0.0496  0.0512  0.0480

******************************************************************************
*

******************************************************************************
*

   AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH
100
-------------------------------------------------------------------------------
                              INCHES         CU. FEET     PERCENT
                        -------------------  -------------  ---------
 PRECIPITATION               13.28   (  2.345)  2892428.2    100.00

 RUNOFF                   0.267  (  0.3268)     58213.89      2.013

 EVAPOTRANSPIRATION          11.944  (  1.9928)  2601438.25    89.940

 PERCOLATION/LEAKAGE THROUGH    1.05573 (  0.27743)   229938.250    7.94966
  FROM LAYER  2

 CHANGE IN WATER STORAGE      0.013   (  0.7108)     2837.92     0.098

******************************************************************************
```

```
******************************************************************************

          PEAK DAILY VALUES FOR YEARS   1 THROUGH  100
-----------------------------------------------------------------------
                                  (INCHES)    (CU. FT.)
                                  ----------  -------------
    PRECIPITATION                        1.94      422532.000

    RUNOFF                            1.424     310063.6250

    PERCOLATION/LEAKAGE THROUGH LAYER  2   0.012680     2761.75220

    SNOW WATER                           1.81       394220.4370


    MAXIMUM VEG. SOIL WATER (VOL/VOL)              0.4285

    MINIMUM VEG. SOIL WATER (VOL/VOL)              0.0773

******************************************************************************
```

```
******************************************************************************

          FINAL WATER STORAGE AT END OF YEAR  100
     ----------------------------------------------------------------------
           LAYER        (INCHES)       (VOL/VOL)
           -----        --------       ---------
             1           0.6096         0.1016

             2          88.8061         0.3700

          SNOW WATER       0.000

******************************************************************************

******************************************************************************
```

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******************************************************************************
**                                                                          **
**                                                                          **
**         HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                    **
**         HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                      **
**         DEVELOPED BY ENVIRONMENTAL LABORATORY                            **
**         USAE WATERWAYS EXPERIMENT STATION                                **
**         FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                  **
**                                                                          **
**                                                                          **
******************************************************************************

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PRECIPITATION DATA FILE:   C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:     C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE: C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:   C:\HELP3\BUTTE.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\BTA3DES1.D10
OUTPUT DATA FILE:          C:\HELP3\BTA3DES1.OUT


TIME: 13:52    DATE:  4/27/1995


******************************************************************************

  TITLE:  BUTTE LANDFILL, ALTERNATIVE 3, PRE 10/9/91 COVER

******************************************************************************
```

```
    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE
         COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                    LAYER  1
                    --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  0
    THICKNESS                  =   24.00  INCHES
    POROSITY                   =   0.4370 VOL/VOL
    FIELD CAPACITY             =      0.1050 VOL/VOL
    WILTING POINT              =     0.0470 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.1101 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  = 0.440000003000E-03 CM/SEC


                    LAYER  2
                    --------

           TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
    THICKNESS                  =   180.00  INCHES
    POROSITY                   =      0.6710 VOL/VOL
    FIELD CAPACITY             =      0.2920 VOL/VOL
    WILTING POINT              =     0.0770 VOL/VOL
    INITIAL SOIL WATER CONTENT =      0.2455 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  = 0.100000005000E-02 CM/SEC


          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

    NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
           SPECIFIED CURVE NUMBER OF 79.0, A SURFACE SLOPE
           OF  1.% AND A SLOPE LENGTH OF  209. FEET.

   SCS RUNOFF CURVE NUMBER            =    78.90
```

```
FRACTION OF AREA ALLOWING RUNOFF  =  100.0   PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =   1.000  ACRES
EVAPORATIVE ZONE DEPTH            =   7.8    INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =    0.597  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =   3.409  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =   0.367  INCHES
INITIAL SNOW WATER                =   0.000  INCHES
INITIAL WATER IN LAYER MATERIALS  =   46.840  INCHES
TOTAL INITIAL WATER               =  46.840  INCHES
TOTAL SUBSURFACE INFLOW           =    0.00  INCHES/YEAR


        EVAPOTRANSPIRATION AND WEATHER DATA
        ----------------------------------

NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
       Butte            Montana

    MAXIMUM LEAF AREA INDEX                 = 3.50
    START OF GROWING SEASON (JULIAN DATE) =  138
    END OF GROWING SEASON (JULIAN DATE)    =  266
    AVERAGE ANNUAL WIND SPEED              = 7.80 MPH
    AVERAGE 1ST QUARTER RELATIVE HUMIDITY  = 63.00 %
    AVERAGE 2ND QUARTER RELATIVE HUMIDITY  = 54.00 %
    AVERAGE 3RD QUARTER RELATIVE HUMIDITY  = 49.00 %
    AVERAGE 4TH QUARTER RELATIVE HUMIDITY  = 63.00 %


NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR    HELENA          MONTANA

       NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL   FEB/AUG   MAR/SEP   APR/OCT   MAY/NOV   JUN/DEC
-------   -------   -------   -------   -------   -------
 0.60      0.40      0.80      1.00      2.10      2.40
 1.30      1.30      1.20      0.80      0.60      0.60


NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR    HELENA          MONTANA
```

```
      NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

    JAN/JUL    FEB/AUG    MAR/SEP    APR/OCT    MAY/NOV    JUN/DEC
    -------    -------    -------    -------    -------    -------
     18.00      24.00      27.00      37.00      47.00      54.00
     61.00      60.00      51.00      41.00      29.00      22.00


     NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
               COEFFICIENTS FOR    HELENA            MONTANA

                STATION LATITUDE  = 45.59 DEGREES


*******************************************************************************
*

     AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------

                 JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                 -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS            0.62     0.36     0.88     1.02     2.12     2.43
                 1.34     1.25     1.25     0.85     0.59     0.58

    STD. DEVIATIONS       0.34     0.24     0.47     0.54     0.93     1.17
                 0.78     0.67     0.84     0.52     0.32     0.31

  RUNOFF
  ------
    TOTALS            0.025    0.018    0.066    0.077    0.072    0.007
                 0.000    0.000    0.000    0.000    0.004    0.007

    STD. DEVIATIONS       0.105    0.054    0.122    0.120    0.246    0.053
                 0.000    0.001    0.002    0.000    0.017    0.019

  EVAPOTRANSPIRATION
```

```
    ------------------
     TOTALS             0.480   0.491   0.680   0.811   1.748   2.539
                   1.379   1.311   1.079   0.663   0.518   0.462

     STD. DEVIATIONS       0.142   0.219   0.245   0.401   0.707   0.911
                   0.862   0.629   0.689   0.392   0.210   0.144

    PERCOLATION/LEAKAGE THROUGH LAYER  2
    ----------------------------------
     TOTALS             0.0766   0.0726   0.0831   0.0817   0.0853   0.0842
                   0.0977   0.0854   0.0627   0.0551   0.0539   0.0637

     STD. DEVIATIONS       0.0462   0.0374   0.0366   0.0320   0.0281   0.0268
                   0.0303   0.0217   0.0272   0.0375   0.0415   0.0431

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     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH
100
  ----------------------------------------------------------------------------
                           INCHES          CU. FEET       PERCENT
                        -------------------   -------------   ---------
  PRECIPITATION                13.28   (  2.345)     48207.1     100.00

  RUNOFF                   0.277   ( 0.3287)     1005.14     2.085

  EVAPOTRANSPIRATION           12.161   ( 2.0015)     44142.95     91.569

  PERCOLATION/LEAKAGE THROUGH     0.90205 (  0.33258)     3274.442     6.79244
   FROM LAYER  2

  CHANGE IN WATER STORAGE       -0.059   (  0.8320)      -215.41     -0.447

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```

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        PEAK DAILY VALUES FOR YEARS   1 THROUGH  100
  --------------------------------------------------------------------
                                   (INCHES)     (CU. FT.)
                                   ----------   -------------
  PRECIPITATION                         1.94       7042.200

  RUNOFF                            1.413      5129.9644

  PERCOLATION/LEAKAGE THROUGH LAYER 2    0.014128     51.28428

  SNOW WATER                            1.81         6570.3403


  MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.3656

  MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0153

*******************************************************************************
```

```
******************************************************************************

          FINAL WATER STORAGE AT END OF YEAR  100
    ----------------------------------------------------------------------
           LAYER      (INCHES)      (VOL/VOL)
           -----      --------      ---------
             1          3.2142       0.1339

             2         37.6913       0.2094

          SNOW WATER       0.000

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******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.01  (14 OCTOBER 1994)                   **
**               DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                 USAE WATERWAYS EXPERIMENT STATION                        **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                          **
**                                                                          **
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******************************************************************************

PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\BTA2DES2.D10
OUTPUT DATA FILE:           C:\HELP3\BTA2DES2.OUT

TIME:  14:53    DATE:   4/27/1995

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  TITLE:  BUTTE LANDFILL, ALTERNATIVE 3, POST 10/9/91 COVER

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```
   NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE
          COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                    LAYER  1
                    --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  0
      THICKNESS                  =    6.00   INCHES
      POROSITY                   =    0.4370 VOL/VOL
      FIELD CAPACITY             =    0.1050 VOL/VOL
      WILTING POINT              =    0.0470 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.0874 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  =  0.440000003000E-03 CM/SEC


                    LAYER  2
                    --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  24
      THICKNESS                  =   18.00   INCHES
      POROSITY                   =    0.3650 VOL/VOL
      FIELD CAPACITY             =    0.3050 VOL/VOL
      WILTING POINT              =    0.2020 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.2708 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  =  0.270000010000E-05 CM/SEC


                    LAYER  3
                    --------

             TYPE 1 - VERTICAL PERCOLATION LAYER
               MATERIAL TEXTURE NUMBER  19
      THICKNESS                  =  180.00   INCHES
      POROSITY                   =    0.1680 VOL/VOL
      FIELD CAPACITY             =    0.0730 VOL/VOL
      WILTING POINT              =    0.0190 VOL/VOL
```

```
    INITIAL SOIL WATER CONTENT =      0.0479 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  = 0.100000005000E-02 CM/SEC




         GENERAL DESIGN AND EVAPORATIVE ZONE DATA
         ----------------------------------------

   NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
          SPECIFIED CURVE NUMBER OF 79.0, A SURFACE SLOPE
          OF  4.% AND A SLOPE LENGTH OF  209. FEET.

   SCS RUNOFF CURVE NUMBER            =    80.00
   FRACTION OF AREA ALLOWING RUNOFF   =   100.0   PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =    1.000  ACRES
   EVAPORATIVE ZONE DEPTH             =     7.8   INCHES
   INITIAL WATER IN EVAPORATIVE ZONE  =    0.841  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =    3.279  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =    0.646  INCHES
   INITIAL SNOW WATER                 =    0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS   =   14.018  INCHES
   TOTAL INITIAL WATER                =   14.018  INCHES
   TOTAL SUBSURFACE INFLOW            =    0.00   INCHES/YEAR




         EVAPOTRANSPIRATION AND WEATHER DATA
         -----------------------------------

   NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          Butte           Montana

     MAXIMUM LEAF AREA INDEX                    = 3.50
     START OF GROWING SEASON (JULIAN DATE)      = 138
     END OF GROWING SEASON (JULIAN DATE)        = 266
     AVERAGE ANNUAL WIND SPEED                  = 7.80 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY      = 63.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY      = 54.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY      = 49.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY      = 63.00 %
     NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
            COEFFICIENTS FOR    HELENA          MONTANA

            NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

   JAN/JUL    FEB/AUG    MAR/SEP    APR/OCT    MAY/NOV    JUN/DEC
   -------    -------    -------    -------    -------    -------
    0.60       0.40       0.80       1.00       2.10       2.40
    1.30       1.30       1.20       0.80       0.60       0.60


     NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
            COEFFICIENTS FOR    HELENA          MONTANA

         NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

   JAN/JUL    FEB/AUG    MAR/SEP    APR/OCT    MAY/NOV    JUN/DEC
   -------    -------    -------    -------    -------    -------
    18.00      24.00      27.00      37.00      47.00      54.00
    61.00      60.00      51.00      41.00      29.00      22.00


     NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
            COEFFICIENTS FOR    HELENA          MONTANA

                STATION LATITUDE = 45.59 DEGREES




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     AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH  100
 ------------------------------------------------------------------------------

                     JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                     -------  -------  -------  -------  -------  -------

 PRECIPITATION
 -------------
```

```
  TOTALS            0.62    0.36    0.88    1.02    2.12    2.43
                    1.34    1.25    1.25    0.85    0.59    0.58

  STD. DEVIATIONS   0.34    0.24    0.47    0.54    0.93    1.17
                    0.78    0.67    0.84    0.52    0.32    0.31

RUNOFF
------
  TOTALS            0.058   0.054   0.165   0.220   0.128   0.009
                    0.000   0.000   0.000   0.000   0.019   0.034

  STD. DEVIATIONS   0.156   0.113   0.227   0.247   0.357   0.065
                    0.001   0.002   0.003   0.000   0.061   0.063

EVAPOTRANSPIRATION
------------------
  TOTALS            0.478   0.478   0.619   0.662   1.666   2.532
                    1.382   1.316   1.082   0.650   0.503   0.455

  STD. DEVIATIONS   0.143   0.207   0.218   0.295   0.700   0.902
                    0.867   0.618   0.681   0.377   0.190   0.141

PERCOLATION/LEAKAGE THROUGH LAYER  3
------------------------------------
  TOTALS            0.0710  0.0622  0.0677  0.0627  0.0625  0.0584
                    0.0455  0.0525  0.0635  0.0726  0.0734  0.0752

  STD. DEVIATIONS   0.0344  0.0269  0.0249  0.0215  0.0206  0.0168
                    0.0196  0.0568  0.0565  0.0487  0.0378  0.0346


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*

   AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH
100
--------------------------------------------------------------------------
                         INCHES          CU. FEET      PERCENT
                    ------------------  ------------  ---------
```

```
PRECIPITATION               13.28   (  2.345)    48207.1    100.00

RUNOFF                    0.689   ( 0.5399)    2500.17      5.186

EVAPOTRANSPIRATION        11.823  ( 1.9804)   42916.26    89.025

PERCOLATION/LEAKAGE THROUGH    0.76728 (  0.31638)    2785.218    5.77761
  FROM LAYER  3

CHANGE IN WATER STORAGE      0.002   ( 0.6612)       5.46     0.011

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        PEAK DAILY VALUES FOR YEARS    1 THROUGH  100
------------------------------------------------------------------------
                                   (INCHES)    (CU. FT.)
                                   ----------  -------------
    PRECIPITATION                        1.94        7042.200

    RUNOFF                              1.536       5574.0234

    PERCOLATION/LEAKAGE THROUGH LAYER  3      0.016298        59.16084

    SNOW WATER                           1.81        6570.3403


    MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.4146

    MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0530

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*******************************************************************************

          FINAL WATER STORAGE AT END OF YEAR  100
    ----------------------------------------------------------------------

           LAYER       (INCHES)      (VOL/VOL)
           -----       --------      ---------
             1          0.7409        0.1235

             2          4.9472        0.2748

             3          8.4805        0.0471

         SNOW WATER       0.000

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******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                  **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                          **
**                                                                          **
******************************************************************************

******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\BTA2DES1.D10
OUTPUT DATA FILE:           C:\HELP3\BTA2DES1.OUT


TIME:  13:42     DATE:   4/27/1995


******************************************************************************

   TITLE:  CLARK TAILINGS, ALTERNATIVE 3 COVER

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```
   NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE
         COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                    LAYER  1
                    --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   0
    THICKNESS                    =     18.00   INCHES
    POROSITY                     =     0.4370 VOL/VOL
    FIELD CAPACITY               =     0.1050 VOL/VOL
    WILTING POINT                =     0.0470 VOL/VOL
    INITIAL SOIL WATER CONTENT   =     0.1047 VOL/VOL
    EFFECTIVE SAT. HYD. COND.    = 0.440000003000E-03 CM/SEC


                    LAYER  2
                    --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER  27
    THICKNESS                    =    240.00   INCHES
    POROSITY                     =     0.4000 VOL/VOL
    FIELD CAPACITY               =     0.3660 VOL/VOL
    WILTING POINT                =     0.2880 VOL/VOL
    INITIAL SOIL WATER CONTENT   =     0.3642 VOL/VOL
    EFFECTIVE SAT. HYD. COND..   = 0.779999993000E-06 CM/SEC


             GENERAL DESIGN AND EVAPORATIVE ZONE DATA
             ----------------------------------------

   NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
          SPECIFIED CURVE NUMBER OF 79.0, A SURFACE SLOPE
          OF  4.% AND A SLOPE LENGTH OF  209. FEET.

   SCS RUNOFF CURVE NUMBER          =    80.00
```

```
FRACTION OF AREA ALLOWING RUNOFF   =  100.0   PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
EVAPORATIVE ZONE DEPTH             =   7.8  INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =    0.583  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =    3.409  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =    0.367  INCHES
INITIAL SNOW WATER                 =    0.000  INCHES
INITIAL WATER IN LAYER MATERIALS   =   89.302  INCHES
TOTAL INITIAL WATER                =   89.302  INCHES
TOTAL SUBSURFACE INFLOW            =    0.00   INCHES/YEAR


          EVAPOTRANSPIRATION AND WEATHER DATA
          ----------------------------------

NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
       Butte              Montana

   MAXIMUM LEAF AREA INDEX                    = 3.50
   START OF GROWING SEASON (JULIAN DATE) =  138
   END OF GROWING SEASON (JULIAN DATE)   =  266
   AVERAGE ANNUAL WIND SPEED                  = 7.80 MPH
   AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 63.00 %
   AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 54.00 %
   AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 49.00 %
   AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 63.00 %


NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR    HELENA          MONTANA

       NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL    FEB/AUG    MAR/SEP    APR/OCT    MAY/NOV    JUN/DEC
-------    -------    -------    -------    -------    -------
  0.60       0.40       0.80       1.00       2.10       2.40
  1.30       1.30       1.20       0.80       0.60       0.60


NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR    HELENA          MONTANA
```

```
    NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

  JAN/JUL   FEB/AUG   MAR/SEP   APR/OCT   MAY/NOV   JUN/DEC
  -------   -------   -------   -------   -------   -------
   18.00    24.00     27.00     37.00     47.00     54.00
   61.00    60.00     51.00     41.00     29.00     22.00


   NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
          COEFFICIENTS FOR    HELENA        MONTANA

               STATION LATITUDE  = 45.59 DEGREES


*******************************************************************************
*

   AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH  100
------------------------------------------------------------------------------

                 JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                 -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
  TOTALS              0.62    0.36    0.88    1.02    2.12    2.43
                 1.34    1.25    1.25    0.85    0.59    0.58

  STD. DEVIATIONS      0.34    0.24    0.47    0.54    0.93    1.17
                 0.78    0.67    0.84    0.52    0.32    0.31

 RUNOFF
 ------
  TOTALS              0.057   0.054   0.166   0.225   0.131   0.008
                 0.000   0.000   0.000   0.000   0.020   0.033

  STD. DEVIATIONS      0.153   0.112   0.229   0.250   0.360   0.055
                 0.001   0.002   0.003   0.000   0.062   0.061

 EVAPOTRANSPIRATION
```

```
  ------------------
  TOTALS           0.476   0.464   0.598   0.650   1.691   2.536
                 1.375   1.311   1.082   0.655   0.517   0.461

  STD. DEVIATIONS      0.144   0.208   0.213   0.297   0.725   0.912
                 0.865   0.623   0.693   0.396   0.212   0.145

 PERCOLATION/LEAKAGE THROUGH LAYER  2
 ------------------------------------
  TOTALS           0.0619  0.0634  0.0767  0.0778  0.0831  0.0884
                 0.0827  0.0541  0.0365  0.0346  0.0390  0.0519

  STD. DEVIATIONS      0.0432  0.0374  0.0389  0.0357  0.0351  0.0342
                 0.0273  0.0223  0.0247  0.0293  0.0352  0.0441


*****************************************************************************
*



*****************************************************************************
*

   AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH
100
 -----------------------------------------------------------------------------
                           INCHES          CU. FEET      PERCENT
                         -------------------  -------------  ---------
 PRECIPITATION                 13.28    (  2.345)    48207.1     100.00

 RUNOFF                     0.693   ( 0.5432)     2517.15      5.222

 EVAPOTRANSPIRATION             11.816   ( 1.9940)    42891.09    88.972

 PERCOLATION/LEAKAGE THROUGH    0.75016 (  0.31030)     2723.088     5.64872
  FROM LAYER  2

 CHANGE IN WATER STORAGE       0.021   ( 0.7596)        75.78      0.157

*****************************************************************************
*
```

```
******************************************************************************

     PEAK DAILY VALUES FOR YEARS   1 THROUGH  100
  ------------------------------------------------------------------------
                              (INCHES)    (CU. FT.)
                              ----------  ------------
  PRECIPITATION                        1.94        7042.200

  RUNOFF                          1.530      5553.9663

  PERCOLATION/LEAKAGE THROUGH LAYER  2     0.011273         40.92215

  SNOW WATER                           1.81          6570.3403

  MAXIMUM VEG. SOIL WATER (VOL/VOL)              0.3589

  MINIMUM VEG. SOIL WATER (VOL/VOL)             0.0152

******************************************************************************
```

```
******************************************************************************

          FINAL WATER STORAGE AT END OF YEAR  100
     ----------------------------------------------------------------------
            LAYER       (INCHES)       (VOL/VOL)
            -----       --------       ---------
              1          2.1613         0.1201

              2         89.2284         0.3718

          SNOW WATER      0.000

******************************************************************************

******************************************************************************
```

```
******************************************************************************

******************************************************************************
**                                                                          **
**                                                                          **
**           HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                  **
**             HELP MODEL VERSION 3.01  (14 OCTOBER 1994)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                **
**                                                                          **
**                                                                          **
******************************************************************************

******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\DATA10.D10
OUTPUT DATA FILE:           C:\HELP3\bsbalt5.OUT


TIME:  19:21    DATE:   5/10/1995


******************************************************************************

  TITLE:  BUTTE LANDFILL, ALTERNATIVE 5 CAP


******************************************************************************
```

```
     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE
          COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                       LAYER  1
                       --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER  0
      THICKNESS                =    12.00  INCHES
      POROSITY                 =    0.4370 VOL/VOL
      FIELD CAPACITY           =    0.1050 VOL/VOL
      WILTING POINT            =    0.0470 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.0942 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.440000003000E-03 CM/SEC



                       LAYER  2
                       --------

                TYPE 2 - LATERAL DRAINAGE LAYER
                 MATERIAL TEXTURE NUMBER 21
      THICKNESS                =     3.00  INCHES
      POROSITY                 =    0.3970 VOL/VOL
      FIELD CAPACITY           =    0.0320 VOL/VOL
      WILTING POINT            =    0.0130 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.0324 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.300000012000     CM/SEC
      SLOPE                    =    4.00   PERCENT
      DRAINAGE LENGTH          =   209.0    FEET


                       LAYER  3
                       --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                 MATERIAL TEXTURE NUMBER 37
      THICKNESS                =     0.03   INCHES
      POROSITY                 =    0.0000 VOL/VOL
```

```
FIELD CAPACITY              =    0.0000 VOL/VOL
WILTING POINT               =    0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT  =    0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.199999999000E-10 CM/SEC
FML PINHOLE DENSITY         =   10.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =   10.00   HOLES/ACRE
FML PLACEMENT QUALITY       = 3 - GOOD


                 LAYER  4
                 --------

       TYPE 3 - BARRIER SOIL LINER
       MATERIAL TEXTURE NUMBER  17
THICKNESS                   =    0.70   INCHES
POROSITY                    =    0.7500 VOL/VOL
FIELD CAPACITY              =    0.7470 VOL/VOL
WILTING POINT               =    0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =    0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.300000003000E-08 CM/SEC


                 LAYER  5
                 --------

     TYPE 1 - VERTICAL PERCOLATION LAYER
       MATERIAL TEXTURE NUMBER   0
THICKNESS                   =   12.00   INCHES
POROSITY                    =    0.4370 VOL/VOL
FIELD CAPACITY              =    0.1050 VOL/VOL
WILTING POINT               =    0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =    0.1046 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.440000003000E-03 CM/SEC


                 LAYER  6
                 --------

     TYPE 1 - VERTICAL PERCOLATION LAYER
```

```
           MATERIAL TEXTURE NUMBER  19
      THICKNESS                 =   180.00  INCHES
      POROSITY                  =   0.1680 VOL/VOL
      FIELD CAPACITY            =     0.0730 VOL/VOL
      WILTING POINT             =    0.0190 VOL/VOL
      INITIAL SOIL WATER CONTENT =      0.0467 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.100000005000E-02 CM/SEC



          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

   NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-
          SPECIFIED CURVE NUMBER OF 79.0, A SURFACE SLOPE
          OF  4.% AND A SLOPE LENGTH OF  209. FEET.

   SCS RUNOFF CURVE NUMBER                =    80.00
   FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =    7.8     INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =      0.491  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE =      3.409  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE =      0.367  INCHES
   INITIAL SNOW WATER                  =     0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =    11.404  INCHES
   TOTAL INITIAL WATER                 =    11.404  INCHES
   TOTAL SUBSURFACE INFLOW             =      0.00  INCHES/YEAR



          EVAPOTRANSPIRATION AND WEATHER DATA
          -----------------------------------

   NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          Butte           Montana

     MAXIMUM LEAF AREA INDEX                =  3.50
     START OF GROWING SEASON (JULIAN DATE) =  138
     END OF GROWING SEASON (JULIAN DATE)   =  266
     AVERAGE ANNUAL WIND SPEED              =  7.80 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 63.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY  = 54.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY  = 49.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY  = 63.00 %


   NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
          COEFFICIENTS FOR     HELENA          MONTANA

          NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL    FEB/AUG    MAR/SEP    APR/OCT    MAY/NOV    JUN/DEC
  -------    -------    -------    -------    -------    -------
    0.60       0.40       0.80       1.00       2.10       2.40
    1.30       1.30       1.20       0.80       0.60       0.60


   NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
          COEFFICIENTS FOR     HELENA          MONTANA

       NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

  JAN/JUL    FEB/AUG    MAR/SEP    APR/OCT    MAY/NOV    JUN/DEC
  -------    -------    -------    -------    -------    -------
   18.00      24.00      27.00      37.00      47.00      54.00
   61.00      60.00      51.00      41.00      29.00      22.00


   NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
          COEFFICIENTS FOR     HELENA          MONTANA

               STATION LATITUDE = 45.59 DEGREES


*******************************************************************************
*

   AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH  100
```

```
--------------------------------------------------------------------------------

                      JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                      -------  -------  -------  -------  -------  -------
PRECIPITATION
-------------
 TOTALS                 0.62     0.36     0.88     1.02     2.12     2.43
                        1.34     1.25     1.25     0.85     0.59     0.58

 STD. DEVIATIONS        0.34     0.24     0.47     0.54     0.93     1.17
                        0.78     0.67     0.84     0.52     0.32     0.31

RUNOFF
------
 TOTALS                0.053    0.050    0.162    0.223    0.129    0.004
                       0.000    0.000    0.000    0.000    0.018    0.030

 STD. DEVIATIONS       0.146    0.105    0.225    0.249    0.359    0.019
                       0.001    0.002    0.002    0.000    0.060    0.057

EVAPOTRANSPIRATION
------------------
 TOTALS                0.464    0.421    0.539    0.626    1.675    2.185
                       1.117    1.047    0.912    0.574    0.446    0.422

 STD. DEVIATIONS       0.153    0.199    0.195    0.302    0.701    0.951
                       0.802    0.602    0.645    0.397    0.241    0.157

LATERAL DRAINAGE COLLECTED FROM LAYER  2
----------------------------------------
 TOTALS               0.0326   0.0186   0.0152   0.0175   0.2136   0.5533
                      0.3376   0.2561   0.2724   0.2259   0.1698   0.0728

 STD. DEVIATIONS      0.0129   0.0040   0.0024   0.0255   0.2488   0.2915
                      0.1561   0.1268   0.1709   0.1563   0.1076   0.0460

PERCOLATION/LEAKAGE THROUGH LAYER  4
------------------------------------
 TOTALS               0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                      0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

 STD. DEVIATIONS      0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                      0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

PERCOLATION/LEAKAGE THROUGH LAYER  6
```

```
 ----------------------------------
  TOTALS           0.0036  0.0031  0.0033  0.0031  0.0031  0.0030
                0.0030  0.0029  0.0028  0.0028  0.0027  0.0027

  STD. DEVIATIONS       0.0101  0.0085  0.0088  0.0080  0.0078  0.0071
                0.0070  0.0066  0.0061  0.0061  0.0056  0.0055


---------------------------------------------------------------------------
        AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
---------------------------------------------------------------------------


 DAILY AVERAGE HEAD ACROSS LAYER  4
 ----------------------------------
  AVERAGES          0.0032  0.0020  0.0015  0.0018  0.0212  0.0567
                0.0335  0.0254  0.0279  0.0224  0.0174  0.0072

  STD. DEVIATIONS       0.0013  0.0004  0.0002  0.0026  0.0247  0.0299
                0.0155  0.0126  0.0175  0.0155  0.0110  0.0046


*****************************************************************************
*



*****************************************************************************
*

   AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH
100
---------------------------------------------------------------------------
                      INCHES          CU. FEET      PERCENT
                    ------------------   -------------   ---------
 PRECIPITATION               13.28   (  2.345)     48207.1     100.00

 RUNOFF                  0.669   ( 0.5443)     2428.78     5.038

 EVAPOTRANSPIRATION            10.426   ( 2.0161)     37846.24     78.508

 LATERAL DRAINAGE COLLECTED     2.18518 (  0.56521)     7932.214   16.45444
  FROM LAYER  2
```

```
PERCOLATION/LEAKAGE THROUGH    0.00031 (  0.00003)       1.123     0.00233
 FROM LAYER  4

AVERAGE HEAD ACROSS TOP        0.018 (   0.005)
 OF LAYER  4

PERCOLATION/LEAKAGE THROUGH    0.03597 (  0.08706)     130.587     0.27089
 FROM LAYER  6

CHANGE IN WATER STORAGE       -0.036  (  0.3987)    -130.70     -0.271

******************************************************************************
*
```

```
*******************************************************************************

        PEAK DAILY VALUES FOR YEARS    1 THROUGH  100
   ----------------------------------------------------------------------------
                                    (INCHES)    (CU. FT.)
                                   ----------  -------------
    PRECIPITATION                        1.94        7042.200

    RUNOFF                           1.533       5565.8945

    DRAINAGE COLLECTED FROM LAYER  2        0.23642      858.18890

    PERCOLATION/LEAKAGE THROUGH LAYER  4    0.000017       0.06194

    AVERAGE HEAD ACROSS LAYER  4            0.727

    PERCOLATION/LEAKAGE THROUGH LAYER  6    0.003386      12.29071

    SNOW WATER                           1.81        6570.3403

    MAXIMUM VEG. SOIL WATER (VOL/VOL)              0.3276

    MINIMUM VEG. SOIL WATER (VOL/VOL)              0.0164

*******************************************************************************
```

```
******************************************************************************

        FINAL WATER STORAGE AT END OF YEAR  100
    ----------------------------------------------------------------------
         LAYER       (INCHES)       (VOL/VOL)
         -----       --------       ---------
           1          1.0955          0.0913

           2          0.0980          0.0327

           3          0.0000          0.0000

           4          0.5250          0.7500

           5          1.0997          0.0916

           6          4.9855          0.0277

        SNOW WATER       0.000

******************************************************************************

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```

SAMPLING AND ANALYSIS PLAN FOR THE BUTTE-SILVER BOW LANDFILL/ CLARK TAILINGS ASSESSMENT OF CORRECTIVE MEASURES INVESTIGATION

RECEIVED

DEC 28 1995

Montana Department of
Environmental Quality
Waste Management Division

DECEMBER 1995

PIONEER
TECHNICAL SERVICES, INC.

P.O. BOX 3445, BUTTE, MONTANA 59702 PHONE (406) 782-5177 FAX (406) 782-5866

100% post-consumer paper & 100% vegetable based inks

FPC
Old Butte L.F. #20
Silver Bow Co.
GW Corr. Meas.
Cu

PIONEER
TECHNICAL SERVICES, INC.
P.O. BOX 3445, BUTTE, MONTANA 59702 PHONE (406) 782-5177 FAX (406) 782-5866

December 27, 1995

RECEIVED
pcl
DEC 28 1995
Montana Department of
Environmental Quality
Waste Management Division

Mr. Pat Crowley
MDEQ/Waste Management Division
P.O. Box 200901
Helena, MT 59620-0901

Dear Pat:

Enclosed is a copy of the Sampling and Analysis Plan for the Butte-Silver Bow Landfill/Clark Tailings Assessment of Corrective Measures Investigation for your review.

Please contact Brad Archibald if you have any questions or comments regarding the report. Thank you.

Sincerely,

Darla Haberman

Darla Haberman
Office Manager

Encl.

cc: Jim Johnston, Butte-Silver Bow
Gary Keeler, Butte-Silver Bow
Brad Archibald, Pioneer

100% post-consumer paper & 100% vegetable based inks

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1.0 INTRODUCTION

This document was prepared for the Butte-Silver Bow County/Department of Public Works (BSB) by Pioneer Technical Services, Inc. (Pioneer). This Sampling and Analysis Plan (SAP) presents the sampling and analytical approach to fill data gaps identified in the "Draft Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment" (Pioneer, 1995). These data are necessary to assess the content and nature of contamination present at the combined Landfill/Clark Tailings site so that corrective measures alternatives can be developed and evaluated. Based on the evaluation of alternatives, a preferred alternative will be selected in accordance with the assessment of corrective measures process detailed in Administrative Rules of Montana (ARM) 16.14.708(7).

This SAP also contains the Standard Operating Procedures (SOPs) that will be utilized when conducting the field sampling activities (Appendix A).

1.1 PROJECT DESCRIPTION

This SAP addresses the Old Butte Sanitary Landfill and the adjacent Clark Tailings. The Old Landfill/Clark Tailings site is located in portions of Sections 25, 26, 35, and 36, Township 3 North, Range 8 West in Butte-Silver Bow County, Montana (Figure 1-1).

On December 23, 1994, a letter was received by Gary Keeler of BSB from Pat Crowley of the Montana Department of Environmental Quality/Solid Waste Program (MDEQ) notifying BSB that the Fourth Quarter 1994 groundwater monitoring results for the Old Butte Sanitary Landfill exceeded the groundwater protection standards for certain constituents of concern (CoCs) listed on Table 2 of ARM 16.14.708. In the same letter, MDEQ notified BSB that additional sampling was required to be conducted during the first quarter of 1995 and that a Corrective Measures Assessment was to be prepared. Based on the data available, the "Draft Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment" report was prepared and submitted in May of 1995 (Pioneer, 1995). The assessment report identified general data collection efforts necessary to complete the assessment of corrective measures process and select the appropriate corrective measure(s). BSB received comments regarding the draft corrective measures document from MDEQ and discussed those comments in ensuing meetings and correspondence. This document has been prepared to present detailed plans to fill the data gaps identified in the draft corrective measures report and ensuing discussions and correspondence.

1.2 PROJECT OBJECTIVE

The purpose of this SAP is to collect sufficient data from the site to perform a detailed analysis of corrective measures alternatives identified in the "Draft Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment."

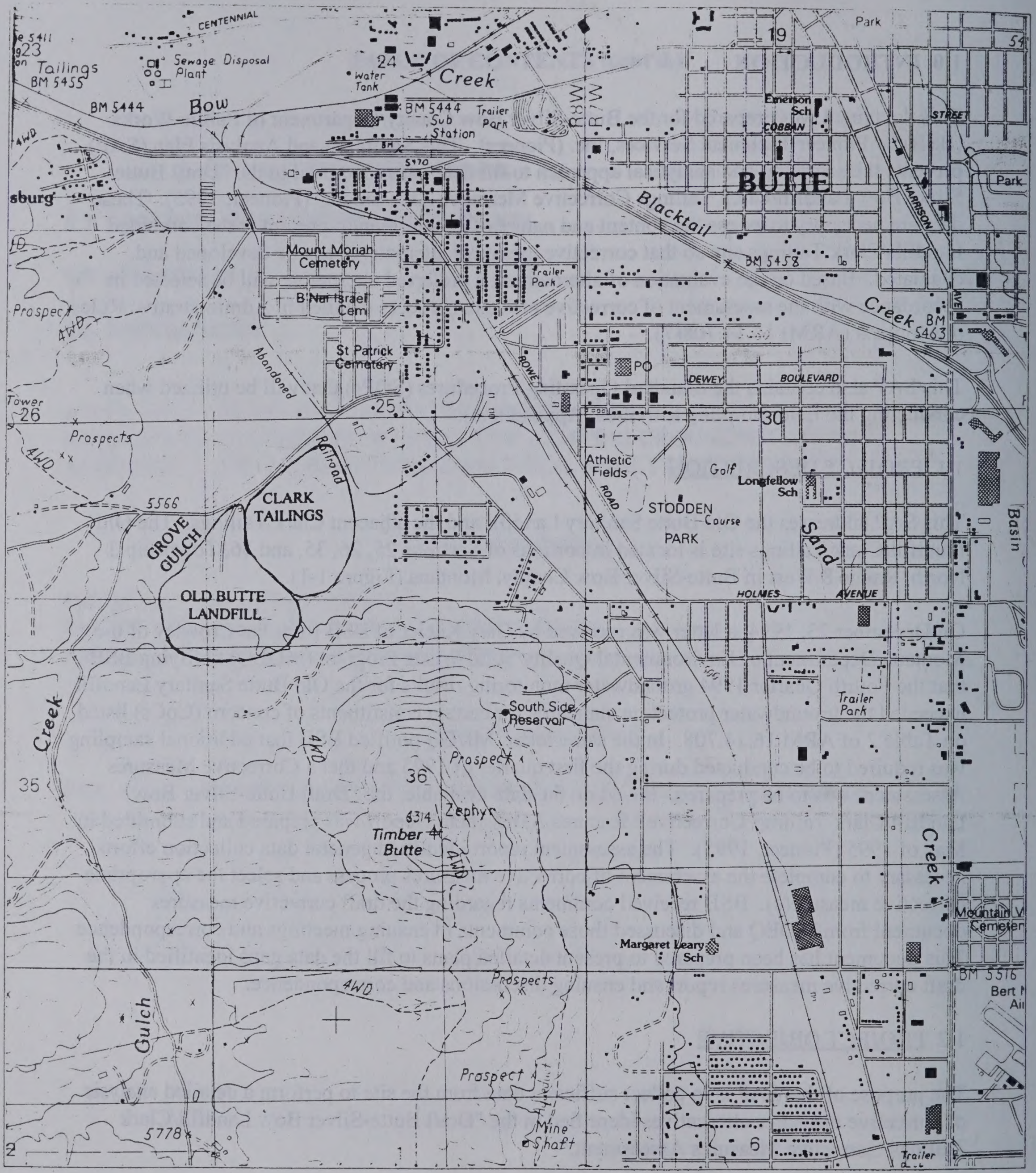

CENTENNIAL
Tailings
BM 5455
Sewage Disposal Plant
Water Tank
24
Creek
Bow
BM 5444
BM 5444
Sub Station
Trailer Park
R8W
R7W
19
Park
Emerson Sch
COBBAN
STREET
BUTTE
HARRISON
Park
sburg
Blacktail
Mount Moriah Cemetery
Trailer Park
BM 5458
B'Nai Israel Cem
Creek
BM 5463
Prospect
4WD
St Patrick Cemetery
Abandoned
ROWE
PO
DEWEY
BOULEVARD
Tower
26
Prospects
25
30
Railroad
Athletic Fields
Golf
Longfellow Sch
4WD
5566
CLARK TAILINGS
GROVE GULCH
STODDEN PARK
Course
ROAD
Sand
Basin
OLD BUTTE LANDFILL
HOLMES
AVENUE
Trailer Park
South Side Reservoir
Creek
Prospect
4WD
35
36
31
Zephyr
6314
Timber Butte
4WD
Creek
Mountain View Cemetery
Margaret Leary Sch
BM 5516
Prospects
4WD
Gulch
Prospect
Mine Shaft
5778
2
1
6
Trailer
N

FIGURE 1-1
SITE VICINITY MAP
OLD BUTTE LANDFILL

PIONEER
TECHNICAL SERVICES, INC.

SCALE: 1" = 24,000"

USGS 7 1/2 Minute Quadrangle, Butte South, MT

Data required to complete the detailed analysis of alternatives include the following.

1. ***Determine the extent and nature of groundwater contamination.***

   Groundwater sampling conducted at the site identified the presence of contaminants at concentrations exceeding groundwater protection standards in wells BSB-A2 and BSB-A3 at the landfill. However, no groundwater protection standards were exceeded in groundwater wells downgradient of the site, including the Blankenship and Cemetery wells. Additional groundwater characterization is necessary to determine the extent of the contaminant plume; the volume of contaminants present; the flow rate/rate of transport of contamination; contaminant attenuation; and the potential impact(s) from the Clark Tailings need to be assessed.

2. ***Determine subsurface characteristics.***

   Additional data are necessary regarding the physical and chemical nature of the subsurface materials to better understand the potential for contaminant migration from the site. Information regarding the undisturbed permeability of the aquifer materials and the total organic carbon content of the subsurface soils are required to estimate the travel time of the contaminant plume and the potential for attenuation of the contaminants.

3. ***Revise the groundwater monitoring plan.***

   Additional groundwater monitoring wells have been installed to fulfill data requirement No. 1 described above. As a result of these new wells, BSB has requested that the Relative Point of Compliance (RPOC) be reestablished (Archibald, 1995a). If MDEQ approves the new RPOC, the groundwater monitoring plan will be revised. Included in this SAP is the general groundwater monitoring approach planned by BSB.

4. ***Waste source characterization.***

   The potential impact of landfill gas on the groundwater must be assessed. Also, it must be determined if landfill gas is migrating from the landfill site. Therefore, a soil gas survey will be conducted to fill these data gaps.

   Sampling is necessary to determine if there are non-aqueous phase liquids (NAPLs) present at the site. Samples will be collected from the bottom of wells BSB-A2 and BSB-A3 to determine if dense non-aqueous phase liquids (DNAPLs) are present. Separate samples may be collected from the surface of these wells, if the water level is below the screened interval, to determine if light non-aqueous phase liquids (LNAPLs) are present.

5. ***Determine cover soil properties.***

Samples of proposed cover soils will be collected and analyzed for agronomic (revegetation) properties so that appropriate soil amendments can be determined. Also, an inventory of native species will be completed so that a revegetation plan can be developed. Additional test pits may be installed in cover soil source areas not previously investigated to assess the amount of soil available and the physical properties of these soils.

6. ***Update the topographic survey.***

The topographic survey of the site and proposed cover soil source areas will be updated to reflect current conditions, including final cover that has been installed and additional filling that has occurred since the last survey (1991) of the site.

2.0 BACKGROUND

The Old Butte-Silver Bow Landfill is located approximately 1 mile southwest of the city of Butte (Figure 1-1). The landfill is located at approximately 45° 58' 38" North latitude and 112° 33' 05" West longitude. Covering approximately 68 disturbed acres, it lies within portions of the SE¼ of Section 26, the SW¼ of Section 25, the NE¼ and the NW¼ of Section 35, and the NW¼ of Section 36 of Township 3 North, Range 8 West in Silver Bow County, Montana. The Clark Tailings cover approximately 60 acres and lie directly adjacent to and east of the Old Landfill (Figure 1-1).

The landfill opened in approximately 1968 and accepted the municipal solid waste from Butte and it's vicinity. The landfill was issued an operating license by the Montana Department of Health and Environmental Sciences (now the MDEQ) in 1978 (a permit was not required previously). Since 1978, the landfill has been inspected on a regular basis by MDEQ personnel.

Landfilling at the site appears to have used a combination of area and trench landfilling methods.

Grove Gulch historically flowed through the northwestern portion of the site. In the early 1980's, a sedimentation basin was constructed immediately west of the landfill by the U.S. Department of Agriculture/Soil Conservation Service (SCS). Discharge from the sedimentation basin was routed generally north of the historic drainage, along the northwest boundary of the landfilled area. At the point where the native drainage meets Little Basin Creek Road (near the northern border of the landfill), Grove Gulch enters a 42-inch diameter reinforced concrete pipe (RCP) culvert, which carries the flow underground until it discharges on the eastern side of the old Burlington Northern Railroad grade, approximately 1,700 feet northeast of the landfill and immediately east of the Clark Tailings.

Run-off from the Clark Tailings and the eastern portion of the landfill is conveyed, via a constructed ditch between the tailings and the landfill, to the Timber Butte Sedimentation Basin, located in the northeastern portion of the Clark Tailings site. This basin is dewatered by a 36-inch diameter perforated RCP riser. The basin was designed to allow for the sedimentation of solids from the Timber Butte Mill Site, surrounding adjacent lands, and the Clark Tailings during runoff events. The perforated riser connects to the RCP diversion of Grove Gulch discussed above. The drop inlet and ditch were also constructed in the early to mid-1980's.

The landfill stopped receiving municipal solid (Group II) wastes from the public on March 14, 1994 (with the opening of the new Butte-Silver Bow Sanitary Landfill). Some construction and demolition debris are still disposed at the site by Butte-Silver Bow contractors, as approved by MDEQ. The public has not had access to the site for refuse disposal since March 14, 1994.

In winter and spring of 1993, a landfill cover material evaluation was conducted (Braun-Intertec, 1993a and 1993b). In March of 1993, an "Interim Closure Plan for the Butte-Silver Bow Landfill" was prepared (SRM, 1993). Based on the information in these reports, the U.S. Department of Agriculture/Forest Service, Anaconda Job Corps began installing the final cover. The Job Corps is continuing with the installation of the final cover at this time. The plan had identified that areas that did not receive waste after October 9, 1991, required a final cap in accordance with MDEQ Solid Waste Regulations in place at that time (two feet of $1x10^{-3}$ cm/sec soils). Areas that received wastes after October 9, 1991, required closure in accordance with more stringent EPA regulations that came into effect at that time (18 inches of $1x10^{-5}$ cm/sec infiltration layer and a 6-inch erosion control layer). Prior to installation of this portion of the final cover, a Construction Quality Control/Construction Quality Assurance Plan (CQA/CQC Plan) will be prepared and submitted to MDEQ for approval.

Much of the area in the southeastern portion of the landfill is mounded; historic filling methods led to the erratic development of this portion of the landfill. In this area, it appears that trenches were arbitrarily cut and filled, resulting in the inconsistent topography and drainages. Currently, vegetation over the landfill is sporadic. There are some areas with good vegetative cover, consisting primarily of bunch grasses. Revegetation of the cap is scheduled to be conducted following completion of all capping activities. Temporary erosion control measures shall be installed to prevent erosion of final cover that has been placed before a vegetative cover can be established.

In July of 1992, BSB was notified by MDEQ that a Hydrogeological and Soils Study, a Groundwater Monitoring Plan, and a Groundwater Sampling and Analysis Plan were required at the landfill (Potts, 1992). Subsequently, a work plan for the Hydrogeological and Soils Study was prepared; it was approved by MDEQ on January 12, 1993 (Potts, 1993). Four monitoring wells were installed (BSB-A1 to BSB-A4). An existing well, MBMG-2, was utilized as a background well. The initial groundwater sampling event was conducted in the spring of 1993. Ensuing groundwater sampling events detected constituents on the ARM 16.14.706, Table 1, list of analytes that exceeded specified action levels. Accordingly, assessment monitoring was conducted and subsequent samples were analyzed for Table 2 constituents. Assessment monitoring results showed that groundwater protection standards were exceeded for contaminants. Therefore, as previously stated, on December 23, 1994, an assessment of corrective measures became necessary as required by ARM 16.14.708(6) (Crowley, 1994). Assessment monitoring continued through March of 1995. In addition, existing downgradient wells were sampled to determine if contaminants had migrated from the site. A "Draft Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment" report was submitted in May of 1995; comments were received from MDEQ in June (Crowley, 1995a); and BSB responded to those comments in September (Archibald, 1995b). This SAP is intended to identify and plan the additional sampling and analysis necessary to fill data gaps so that a detailed analysis of corrective measures alternatives can be completed and an appropriate corrective measure selected.

3.0 WASTE CHARACTERISTICS

3.1 BUTTE-SILVER BOW LANDFILL

The Butte-Silver Bow Landfill served as a municipal solid waste repository from approximately 1968 until it closed in 1994. As such, typical municipal solid wastes (or Group II wastes per MDEQ regulations at ARM 16.14.503) were disposed at the site. The specific quantity of wastes on-site are not known. However, based on an average depth of waste of 15 feet over an estimated 60 acres that received wastes, and a 4:1 waste:cover soil ratio, and an average in-place waste density of 1,000 lbs./cubic yd. (SWANA, 1991), approximately 600,000 tons of refuse have been disposed at the site. This would equal an average generation rate of 4 pounds per capita per day during the life of the landfill. This is consistent with the typical solid waste generation values reported by SWANA (1991) and slightly higher than those reported by McBean, et al (1995).

Wastes landfilled at the site may have potentially led to elevated concentrations of CoCs in localized groundwater, as determined by the groundwater monitoring conducted to date. As a result, the assessment of corrective measures process commenced. Based on a statistical analysis of the groundwater monitoring sampling conducted as of August of 1995, the following contaminants have exceeded groundwater protection standards in landfill monitoring wells:

- Cadmium (mean and median, well BSB-A2);
- Iron (mean and median, wells BSB-A2 and BSB-A3);
- Cobalt (mean and median, wells BSB-A2 and BSB-A3);
- Zinc (mean only, well BSB-A2);
- Sulfate (mean only, well BSB-A2);
- Chloroethane (mean and median, well BSB-A3);
- 1,1-dichloroethane (mean and median, well BSB-A2);
- cis-1,2-dichloroethene (mean and median, well BSB-A2);
- tetrachloroethene (mean and median, well BSB-A2);
- Trichloroethene (mean and median, well BSB-A2); and
- Vinyl chloride (mean and median, well BSB-A2).

No groundwater protection standards were exceeded in a new downgradient well (BSB-A5, installed in July of 1995) during the August 1995 assessment monitoring sampling. As recommended by MDEQ, an additional monitoring well (BSB-A6) was installed north and east of BSB-A2 in October of 1995. Sampling results indicate that this well may contain contaminants at concentrations exceeding groundwater protection standards. These results were forwarded to MDEQ (Bisch, 1995a).

3.2 CLARK TAILINGS

The source of the Clark Tailings was the Timber Butte Mill, which began operation in 1914 and was dismantled in 1948. During it's years of operation, the mill served primarily as a zinc and copper concentrator. Ore from the Elm Orlu Mine, north of Butte and east of Walkerville, was processed at the mill. According to a 1915 paper on the operation of the mill (Simons, 1915), the tailings from the mill contained the following fractions (in parts per million):

- copper: 700;
- silver: 19;
- gold: 0.053;
- iron: 1,400;
- zinc: 12,000;
- lead: 500; and
- insolubles (percent): 95.12.

The Clark Tailings were reclaimed in the mid-1980's by the Anaconda Company. While much of area was regraded, covered, and revegetated, there are many areas where tailings are currently present at the surface.

Per a 1989 EPA Administrative Order on Consent, the CoCs for the Timber Butte Mill Site (the source of the Clark Tailings) were: arsenic, cadmium, lead, zinc, and copper. This Order required a Removal Action at the Mill Site (which was conducted in 1989). The Order mentions reclamation of a drainage immediately east of the Clark Tailings, but did not address the Clark Tailings directly.

Four samples collected from the upper two feet of the Clark Tailings have been analyzed for metals content (two samples collected in 1982 and two samples collected in 1987). The following concentration ranges were reported (McCulley, Frick, and Gilman, 1993):

- arsenic: 166 to 934 mg/kg;
- copper: 314 to 761 mg/kg;
- lead: 335 to 1,440 mg/kg; and
- zinc: 1,210 to 4,640 mg/kg.

The tailings may be the source of inorganic contaminants that exceed groundwater protection standards in the landfill monitoring wells, particularly the heavy metals.

4.0 CORRECTIVE MEASURES ASSESSMENT INVESTIGATION TASKS

The "Draft Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment" (Pioneer, 1995) outlines general site characterization tasks necessary to complete a detailed analysis of reclamation alternatives. These tasks include sampling, analyzing, and measuring waste sources and groundwater. Tasks also include evaluating contaminant pathways, preparing an accurate topographic map of the area, and assessing the volume and nature of potential cover soils.

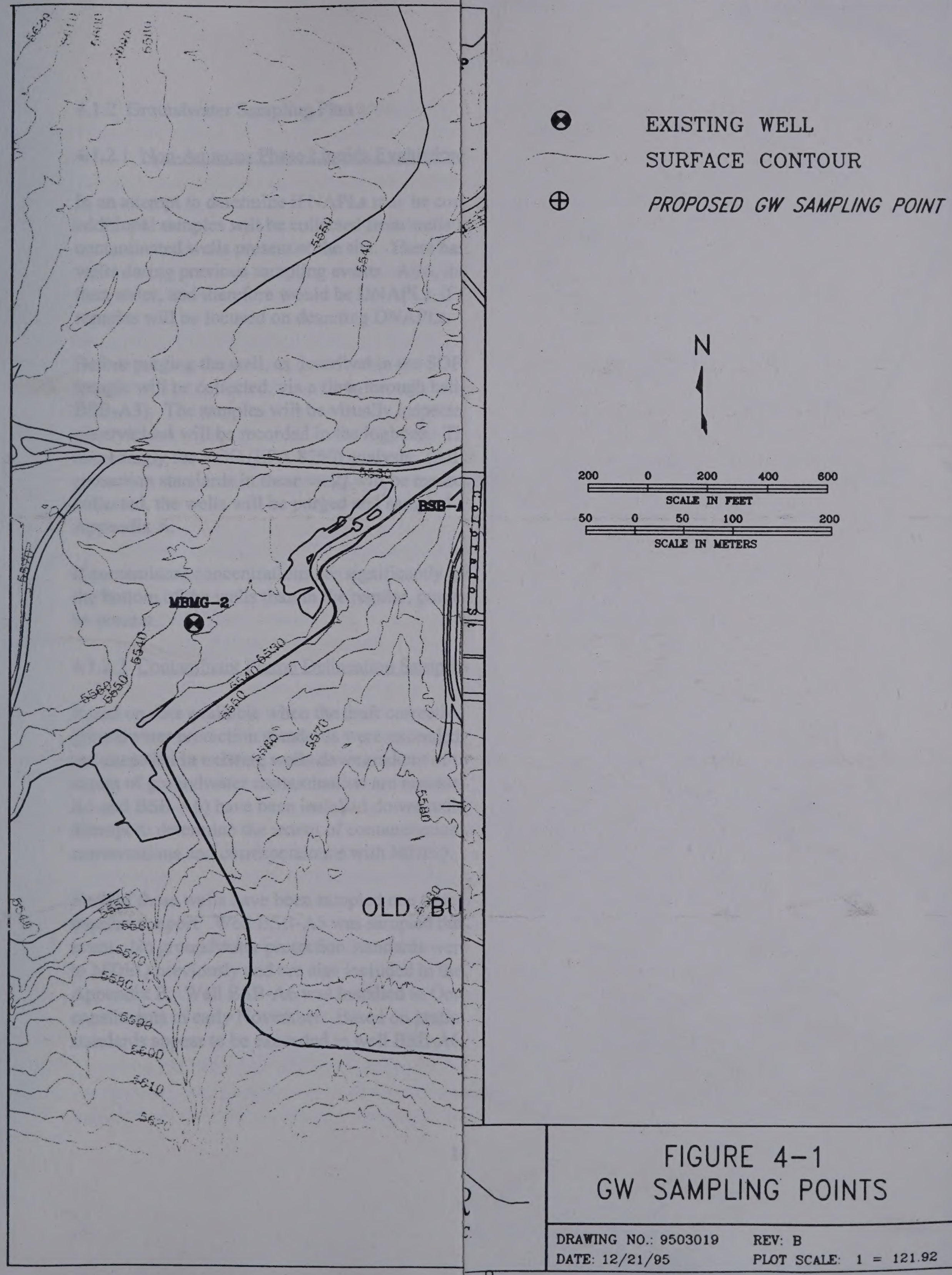
The field SOPs are presented in Appendix A. The SOPs detail methodology for sampling and field analysis activities.

4.1 GROUNDWATER SAMPLING

4.1.1 Existing Data and Conditions

Additional groundwater sampling is necessary to determine the extent of the contaminant plume and to better understand the nature of the contaminants. Based on existing data, groundwater protection standards have been exceeded at wells located at the landfill boundary (BSB-A2 and BSB-A3). However, groundwater protection standards have not been exceeded in existing downgradient wells that were sampled in April of 1995 (Pioneer, 1995) or in a new well (BSB-A5) installed downgradient of well BSB-A2 in July of 1995. The new well had been proposed to MDEQ and installed in an attempt to determine the extent of the groundwater contamination. (This well, along with the other existing groundwater monitoring wells at the landfill, were sampled as required by solid waste regulations in August of 1995. Data were provided to MDEQ in October [Bisch, 1995b].) Well locations are shown on Figure 4-1, and the statistical analysis of the existing data is presented in Appendix B.

Based on the groundwater flow direction data and the fact that BSB was in the process of acquiring the adjacent Clark Tailings, BSB requested that the RPOC be moved to a point defined by wells BSB-A1 and BSB-A5, in accordance with ARM 16.14.708(10) (Archibald, 1995a). MDEQ responded that additional data were necessary to delineate the extent of the contaminant plume, particularly in the area east of existing wells BSB-A2 and BSB-A3 (Crowley, 1995b). BSB agreed to install one additional well in this area (Archibald, 1995b). This well, BSB-A6, was installed on October 26, 1995 and was sampled for Table 1 constituents on November 10, 1995. The location of the new well is shown on Figure 4-1. Preliminary results for well BSB-A6 indicate that volatile organic compounds (VOCs) are present in the well. One organic compound, trichloroethene, appears to slightly exceed the groundwater protection standard. The organic compound data have been forwarded to MDEQ (Bisch, 1995a). Heavy metals data indicate that cadmium, iron, nickel, and zinc may exceed groundwater protection standards, also.



⊗ EXISTING WELL
SURFACE CONTOUR
⊕ *PROPOSED GW SAMPLING POINT*
N
200 0 200 400 600
SCALE IN FEET
50 0 50 100 200
SCALE IN METERS
MBMG-2
BSB-A
OLD BU
5620
5610
5600
5590
5580
5570
5560
5550
5540
5530

FIGURE 4-1
GW SAMPLING POINTS

DRAWING NO.: 9503019 REV: B
DATE: 12/21/95 PLOT SCALE: 1 = 121.92

4.0 CORRECTIVE MEASURES ASSESSMENT INVESTIGATION TASKS

The "Draft Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment" (Pioneer, 1995) outlines general site characterization tasks necessary to complete a detailed analysis of reclamation alternatives. These tasks include sampling, analyzing, and measuring waste sources and groundwater. Tasks also include evaluating contaminant pathways, preparing an accurate topographic map of the area, and assessing the volume and nature of potential cover soils.

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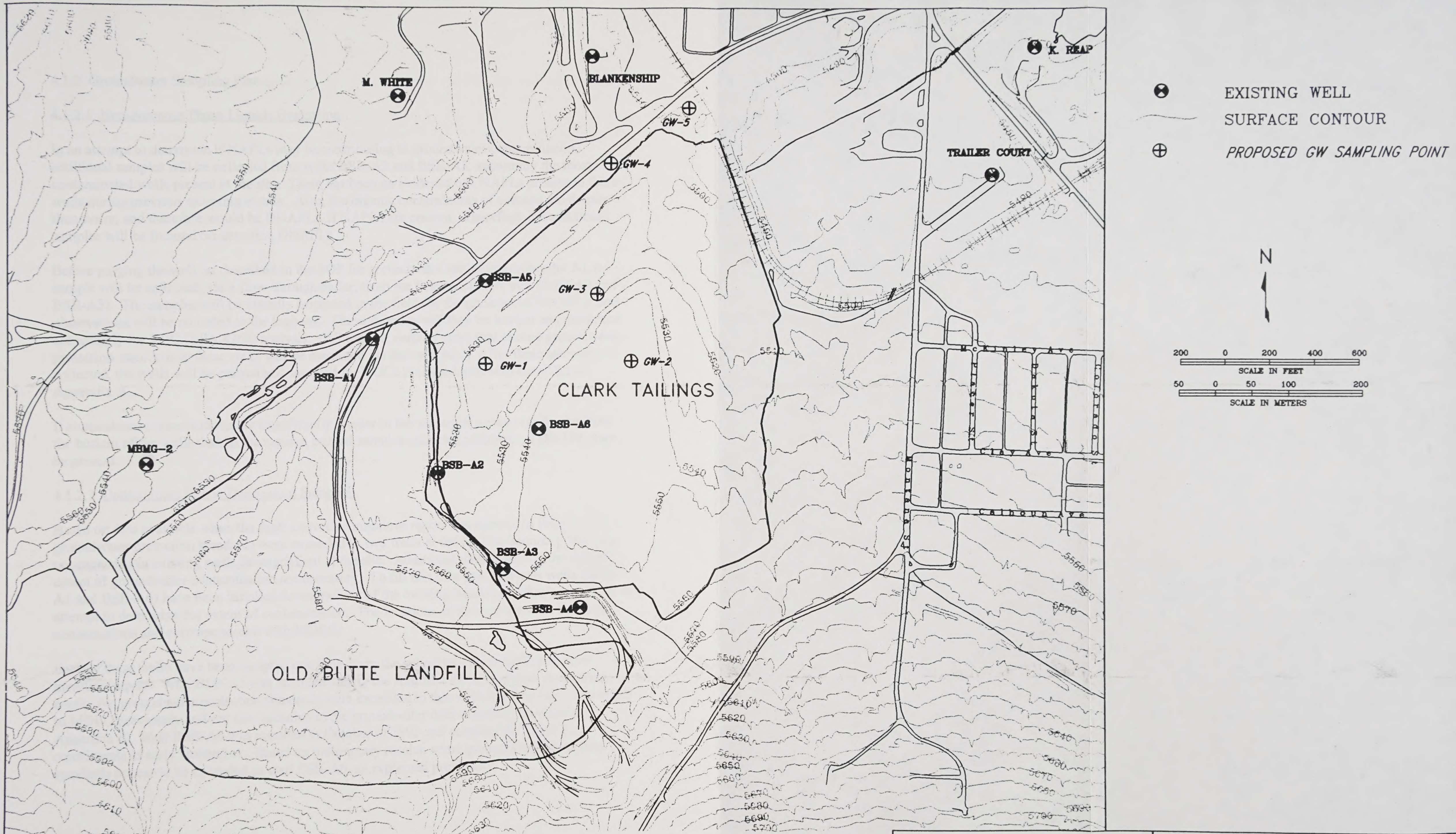
M. WHITE
BLANKENSHIP
K. REAP
TRAILER COURT
GW-5
GW-4
GW-3
GW-2
GW-1
BSB-A5
BSB-A1
BSB-A6
BSB-A2
BSB-A3
BSB-A4
MBMG-2
CLARK TAILINGS
OLD BUTTE LANDFILL
McKinley Ave
Clay Ave
Calhoun Ave
Montana St
Placer St
Colorado
EXISTING WELL
SURFACE CONTOUR
PROPOSED GW SAMPLING POINT
N
200 0 200 400 600
SCALE IN FEET
50 0 50 100 200
SCALE IN METERS

PIONEER
TECHNICAL SERVICES, INC.

FIGURE 4-1
GW SAMPLING POINTS

DRAWING NO.: 9503019 REV: B
DATE: 12/21/95 PLOT SCALE: 1 = 121.92

4.1.2 Groundwater Sampling Plan

4.1.2.1 Non-Aqueous Phase Liquids Evaluation

In an attempt to determine if NAPLs may be contributing to groundwater contamination, additional samples will be collected from wells BSB-A2 and BSB-A3, apparently the most contaminated wells present at the site. There has been no evidence of LNAPLs present in these wells during previous sampling events. Also, the organic contaminants of concern are denser than water, and therefore would be DNAPLs, if NAPLs are present. Therefore, the additional samples will be focused on detecting DNAPLs.

Before purging the well, as described in the SOP for groundwater sampling (Appendix A), a sample will be collected, via a flow-through bailer, from the bottom of each well (BSB-A2 and BSB-A3). The samples will be visually inspected in the field for the presence of DNAPLs, and observations will be recorded in the logbook. These samples will then be bottled and preserved accordingly for VOC (EPA 8260) analysis. (All organic contaminants that exceed groundwater protection standards in these wells will be measured via this analysis.) After these samples are collected, the wells will be purged and sampled for VOCs in accordance with the SOPs in Appendix A.

If contaminant concentrations are significantly greater in the unpurged samples collected from the bottom of the wells than in the regular, purged samples collected afterward, a DNAPL may be present.

4.1.2.2 Contaminant Plume Delineation Sampling

Based on data available when the draft corrective measures report was submitted (May 1995), groundwater protection standards were exceeded in two wells at the landfill boundary, but were not exceeded in existing wells downgradient of the site. Additional data regarding the spatial extent of groundwater contamination are necessary. To fill this data gap, two new wells (BSB-A5 and BSB-A6) have been installed downgradient of the existing landfill monitoring wells in an attempt to determine the extent of contamination. The locations of these wells were based on conversations and correspondence with MDEQ.

Each of these wells have been sampled one time since the submittal of the draft corrective measures report. Well BSB-A5 was sampled during the August 1995 assessment monitoring event. No groundwater protection standards were exceeded in this well; the data were forwarded to MDEQ previously and are also included in the groundwater data summary provided in Appendix B. Well BSB-A6 was installed in October of 1995 and sampled for Table 1 constituents in early November. Based on preliminary results, some groundwater protection standards appear to be exceeded in well BSB-A6, as explained previously.

Based on the apparent presence of contaminants in well BSB-A6, verification sampling of this well will take place in December of 1995. Verification sampling will also be conducted in well BSB-A5 at the same time, since it has only been sampled once to date. The verification samples will be analyzed for VOCs (EPA 8260) and metals.

If groundwater protection standards are apparently exceeded in well BSB-A6, based on the initial and verification sampling results, additional groundwater samples may be collected downgradient of the well while conducting the soil gas survey described in Section 4.3. These samples would be one-time samples used to delineate the extent of contamination. Possible sampling locations are shown on Figure 4-1. Samples would be collected through a screen selected in the field based on the aquifer materials. Based on conditions in the existing wells, the screen used will most likely be a stainless steel screen with 0.020-inch slots. These samples would be analyzed for VOCs and those metals which exceed groundwater protection standards in the landfill monitoring wells and/or have been identified as contaminants of concern for the Timber Butte Millsite Removal Action. These metals are cadmium, iron, zinc, cobalt, nickel, arsenic, and copper.

4.1.2.3 Assessment Monitoring

Currently, one background well (MBMG-2) and six "downgradient" wells (BSB-A1 through BSB-A6) exist at the site. The RPOC is currently defined by wells BSB-A1, BSB-A2, BSB-A3, and BSB-A4. Wells BSB-A5 and BSB-A6 have been installed further downgradient of the site in an effort to delineate the extent of the contaminant plume. Furthermore, these new wells are on land which is in the process of being acquired by BSB from Inland Properties, Inc.

The wells that currently define the RPOC will continue to be sampled semi-annually in accordance with groundwater assessment monitoring regulations at ARM 16.14.708(a)(1)(v). These regulations require analysis for all Table 2 constituents at least annually. During the other sampling event each year, samples must be analyzed for all Table 1 constituents and any Table 2 constituents previously detected. The next scheduled sampling event as part of assessment monitoring is in February of 1996.

If and when MDEQ moves the RPOC to the line defined by wells BSB-A1, BSB-A5, and BSB-A6, in accordance with BSB's request, those wells will be sampled semi-annually in accordance with the assessment monitoring regulations at ARM 16.14.708(a)(1)(v). If necessary, additional samples will be collected from the new wells in order to obtain the minimum of four independent samples required by ARM 16.14.708(a)(1)(iv). The other wells (BSB-A2, BSB-A3, and BSB-A4) will be maintained during the corrective measures process in case information on groundwater quality from these wells is required. These wells eventually will be abandoned once groundwater protection standards are achieved at the RPOC, as defined by ARM 16.14.708(5).

All groundwater sampling activities will be conducted as per Pioneer's SOPs (Appendix A).

4.2 AQUIFER CHARACTERISTICS SAMPLING

In order to better assess the rate of potential contaminant transport from the site, subsurface soil samples were collected during the installation of well BSB-A5 in July of 1995 (see Figure 4-1 for the well location).

An undisturbed core sample from 41 feet below ground surface (bgs) was submitted for determination of permeability via ASTM D 5084 Method C (falling head, rising tailwater). This sample was immediately above the water table. The material sampled was a silty clayey sand; this sample was slightly plastic and contained more fines than the majority of the soils encountered when installing the well. The data are included in Appendix C.

Three additional soil samples were collected and submitted for total organic carbon content analysis to assess the potential for contaminant attenuation. These samples were collected from 27, 39, and 45 feet bgs. The materials all consisted of fine to medium sand with minor fines, which was typical of the majority of materials encountered during well installation. The material contained no detectable organic carbon. Data are included in Appendix C.

Additional subsurface soil samples may be collected for total organic carbon analysis and/or permeability analysis if different materials are encountered while conducting the soil gas survey, described in Section 4.3. These opportunity samples will only be collected if it becomes apparent that a significant amount of soils unlike those already sampled are present at the site.

4.3 SOIL GAS SAMPLING

Because of the possibility that landfill gas could be contributing to the VOCs present in the groundwater, a soil gas survey will be conducted. This survey will focus on the vicinity of wells BSB-A2 and BSB-A3. Additional soil gas measurements will be taken at the perimeter of the property owned by, or currently under acquisition by, BSB. Soil gas survey sampling points are shown on Figure 4-2. These survey points will be used to determine if landfill gas is migrating from the site, as required by ARM 16.14.521(f).

The soil gas survey will be conducted with the assistance of a portable soil probing unit (geoprobe). Soil borings will be advanced to the approximate depth of waste or to groundwater. Two discrete soil gas samples will be extracted from the borings: one sample from approximately one-half the total depth of the boring and the second sample from the bottom of the boring. The soil gas samples will be analyzed on-site for explosivity (with an oxygen/explosivity meter); total organic vapors (with a photoionization detector or portable gas chromatograph); and the specific organic compounds tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, vinyl chloride, and chloroethane (with a portable gas chromatograph calibrated for these specific compounds). The detection limit via this field analytical method is approximately 1 part per billion for each compound. Of those samples in which organic vapors are detected, split samples will be collected from approximately 20% of the wells. These split samples will be collected in a laboratory-supplied Tedlar bag and will be sent to an analytical

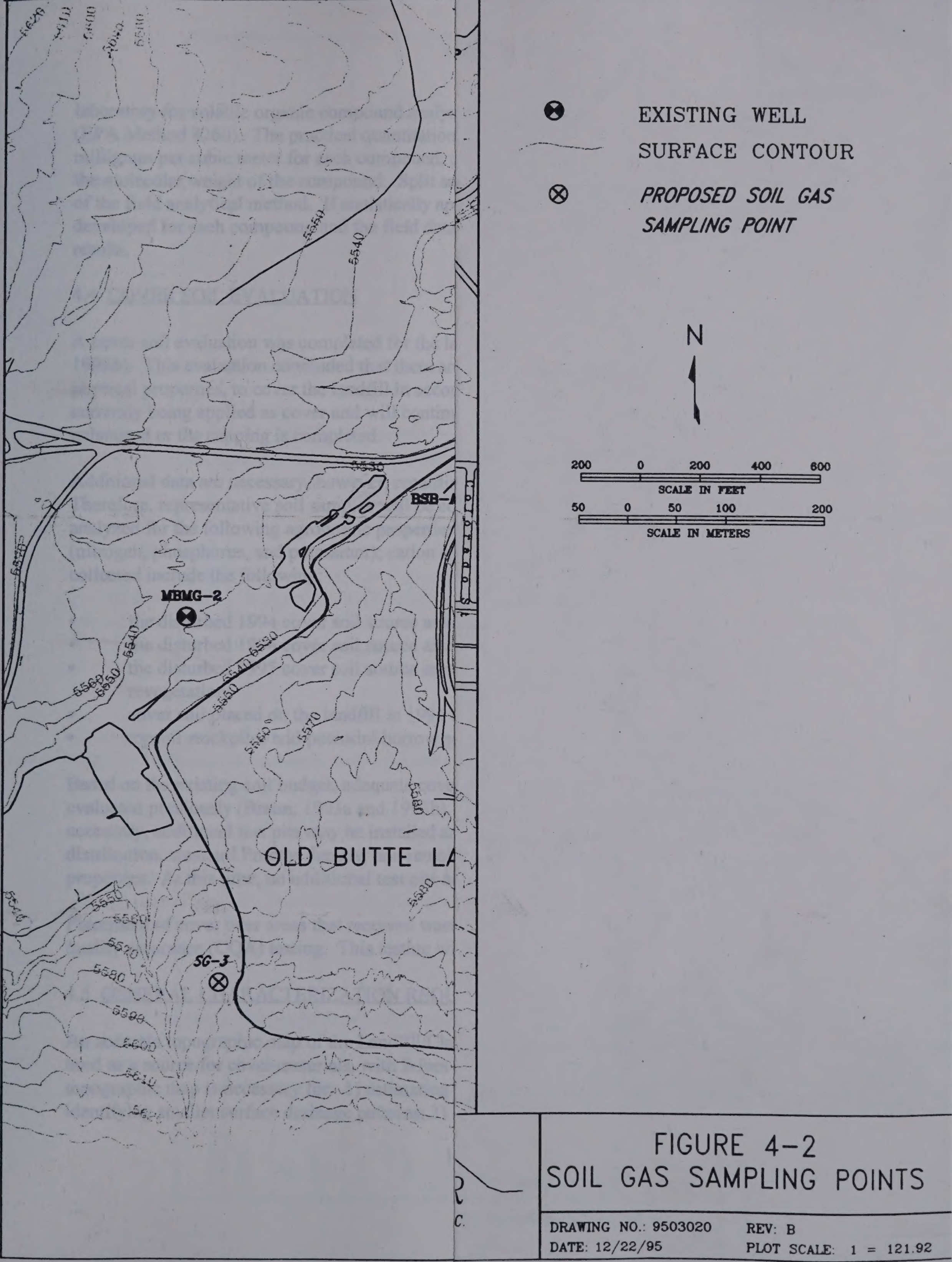
EXISTING WELL
SURFACE CONTOUR
PROPOSED SOIL GAS SAMPLING POINT
N
200 0 200 400 600
SCALE IN FEET
50 0 50 100 200
SCALE IN METERS
MBMG-2
BSB-A
SG-3
OLD BUTTE LA
5540
5530
5550
5560
5570
5580
5590
5600
5610
5620

FIGURE 4-2
SOIL GAS SAMPLING POINTS

DRAWING NO.: 9503020
REV: B
DATE: 12/22/95
PLOT SCALE: 1 = 121.92

4.2 ADDITIONAL VADOSE ZONE SOIL SAMPLING

In order to better assess the rate of potential contaminant migration from the site, vadose zone soil samples were collected during the installation of well ST-5A4 in July of 1995 (see Figure 4-4 for the well location).

An undisturbed core sample from 41 and 45 feet below ground surface (bgs) was submitted for the determination of permeability via ASTM D-2434. [illegible] sample was [illegible] above the water table. The material sampled was [illegible] this sample was slightly [illegible] than the [illegible] encountered when installing the wells. The data are included in Appendix C.

Three additional soil samples were collected and submitted for total organic carbon content analysis to assess the potential for contaminant adsorption. These samples were collected from 25, 35, and 45 feet bgs. The materials all consisted of fine to medium sand [illegible] which was typical of the majority of materials encountered during well installation. The materials contained no detectable organic carbon. Data are included in Appendix C.

Additional subsurface soil samples may be collected for total organic carbon analysis and/or permeability analyses if different materials are encountered while conducting the soil gas survey described in Section 4.3. [illegible] samples will only be collected if it becomes apparent that a significant amount of organic [illegible] the presence of the [illegible]

4.3 SOIL GAS SAMPLING

Because of the possibility that landfill gas could be contributing to the VOC impacts to the groundwater, a soil gas survey will be conducted. This survey will focus on the vicinity of wells ST-5A1 and ST-5A4. [illegible] soil gas measurements will be taken at the perimeter of the [illegible] shown on Figure 4-2. The soil gas data will be used to determine the potential for gas migration from the site, as required by ARM 16.14.521(1).

The soil gas survey will be conducted with the assistance of a portable soil boring unit. [illegible] borings will be advanced to the approximate depth of water [illegible] soil gas samples will be extracted from [illegible] the [illegible] of the boring. [illegible] soil gas samples will be analyzed on site for [illegible] total organic vapors with a photoionization detector or portable gas chromatograph, and for specific organic [illegible] compounds. The detection limit via this field analytical method is approximately 1 part per billion for each compound. If [illegible] are detected, split samples will be collected from approximately 20% of the wells. These split samples will be collected in a laboratory-supplied Tedlar bag and will be sent to an analytical

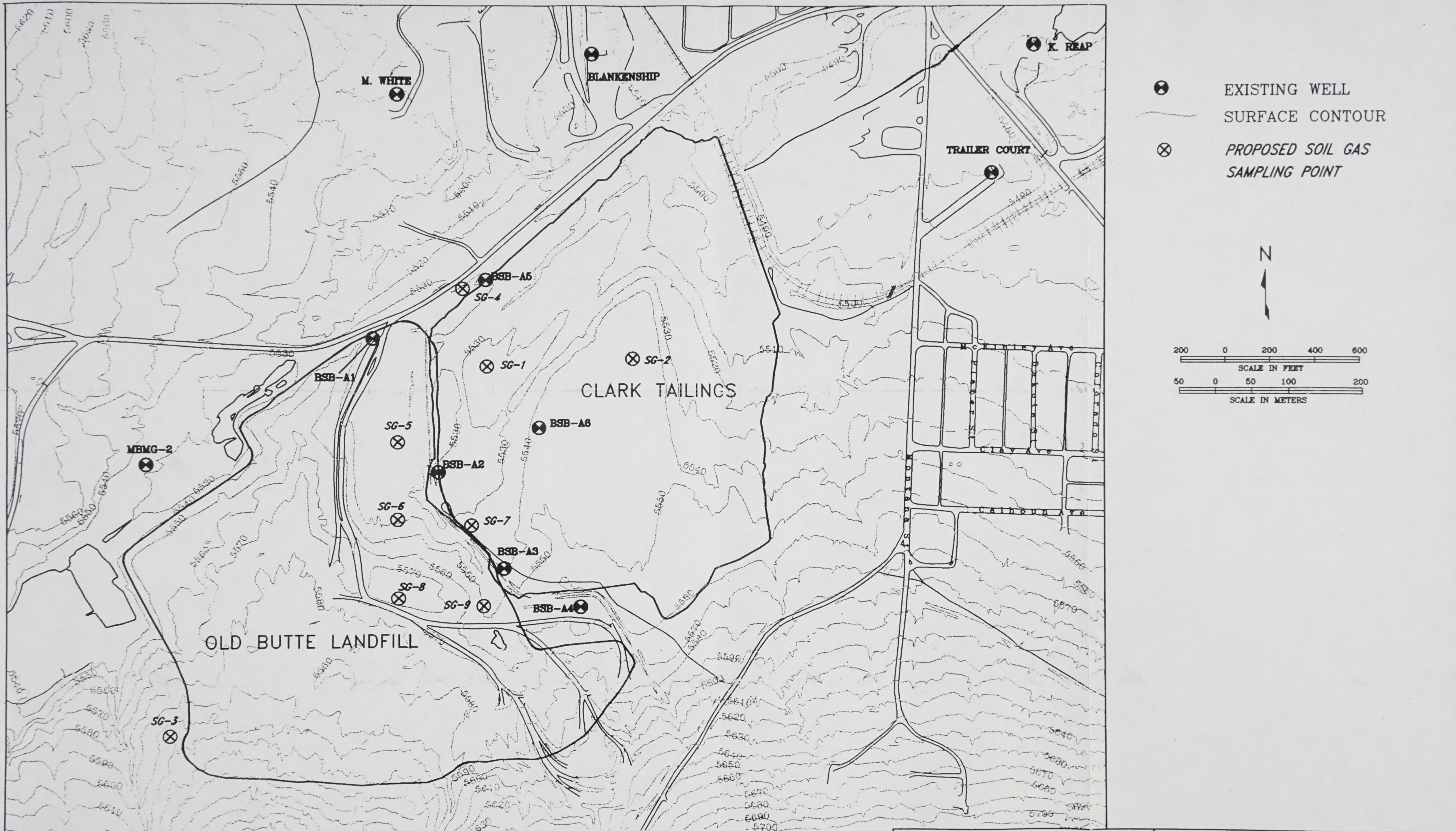
M. WHITE
BLANKENSHIP
K. REAP
TRAILER COURT
BSB-A5
SG-4
BSB-A1
SG-1
SG-2
CLARK TAILINGS
BSB-A6
SG-5
MBMG-2
BSB-A2
SG-6
SG-7
BSB-A3
SG-8
SG-9
BSB-A4
OLD BUTTE LANDFILL
SG-3
McKinley Ave
Placer St
Clay Ave
Calhoun Ave
Montana St
Colorado
EXISTING WELL
SURFACE CONTOUR
PROPOSED SOIL GAS SAMPLING POINT
N
200 0 200 400 600
SCALE IN FEET
50 0 50 100 200
SCALE IN METERS

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FIGURE 4-2
SOIL GAS SAMPLING POINTS

DRAWING NO.: 9503020
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laboratory for volatile organic compound analysis via gas chromatography/mass spectrometry (EPA Method 8260). The practical quantitation limit (PQL) by this analytical method is 2.5 milligram per cubic meter for each compound, or approximately 1 part per million, depending on the molecular weight of the compound. Split sample results will be used to check the accuracy of the field analytical method. If statistically appropriate and necessary, correction curves will be developed for each compound and the field data will be corrected based on the split sample results.

4.4 COVER SOIL EVALUATION

A cover soil evaluation was completed for the landfill in 1993 (Braun-Intertec, 1993a and 1993b). This evaluation concluded that there are adequate soils available on-site, based on their physical properties, to cover the landfill in accordance with MDEQ regulations. These soils are currently being applied as cover and will continue as the cover soil source until they are exhausted or the capping is completed.

Additional data are necessary, however, regarding the agronomic properties of the cover soil. Therefore, representative soil samples will be collected from the cover soil sources and will be analyzed for the following agronomic properties: organic matter content; nutrient content (nitrogen, phosphorus, and potassium); cation exchange capacity; and pH. Soil samples to be collected include the following:

- the disturbed 1994 cover soil source area that has not yet had a topsoil lift applied;
- the disturbed 1994 cover soil source area that has had a topsoil lift applied;
- the disturbed 1995 cover soil source area that has not had topsoil applied and will require revegetation;
- cover soil placed on the landfill in 1994 that has not yet had a topsoil lift applied; and
- topsoil stockpiles and potential borrow sources.

Based on the existing soil budget, adequate cover soils are available from the cover soil sources evaluated previously (Braun, 1993a and 1993b). In the event that additional cover soils become necessary, additional test pits may be installed and samples collected for physical (particle size distribution, standard Proctor density, and remolded permeability, as necessary) and agronomic properties. At this time, no additional test pits are planned.

Placement of cover over areas that received waste after October 9, 1991, will require construction quality assurance (CQA) testing. This testing will be conducted as defined in the CQA plan.

4.5 GENERAL CHARACTERIZATION REQUIREMENTS

An accurate topographic map of the Landfill/Clark Tailings site, and adjacent sites that may be used as a source for cover materials, with 2-foot contour intervals will be prepared. The topographic map is necessary for: 1) estimating volumes and areas of disturbed areas; 2) identifying smaller surface drainage patterns; 3) identifying locations for diversions, run-on/runoff controls, and sedimentation basins; 4) identifying and sizing temporary roads for heavy equipment; 5) conducting an analysis of the hydrologic configuration of Grove Gulch Creek; and 6) planning for the final end use of the site. The survey will be based on a reproducible grid system (e.g., State Plane NAD83 coordinate system) with enough horizontal and vertical control points staked in the field so that the survey can be reproduced.

5.0 SAMPLING PROTOCOL

5.1 FIELD PROCEDURES

All field activities including sampling and analytical methods, sample preservation, quality assurance/quality control (QA/QC) samples and procedures, equipment and personnel decontamination, sample designation and handling, and documentation will follow the SOPs included in Appendix A. These SOPs have been reviewed and approved by MDEQ. MDEQ comments and Pioneer's response to those comments are included in Appendix A.

5.1.1 Equipment Decontamination

All equipment will be decontaminated prior to use in the field. Equipment decontamination consists of a tap water rinse; a soap and tap water wash; a dilute nitric acid (HNO_3) rinse (10 parts distilled/deionized (DI) water to 1 part concentrated HNO_3); a methanol rinse; and a DI water rinse followed by air drying, and wrapping with aluminum foil. All equipment will also be decontaminated before leaving the site to prevent off-site transport of contaminants.

5.1.2 Sample Designation and Labeling

Samples will be identified by their location and date of their collection. Groundwater samples will be identified by the well number and sample collection date. Solid media samples will be described by their location and depth. Gaseous phase samples will be identified by their location and date of collection.

All samples will be labeled in the field; the date and time of sample collection, the sample number, preservatives used, analyses requested, and the sampler's initials will all be documented. A permanent marker will be used for labeling, and labels will be covered with clear tape and sealed and tagged per EPA procedures.

5.1.3 Sample Preservation and Handling

Samples will be preserved immediately upon sample collection if applicable. Sample preservation, containers, and holding times are listed in Table 5-1. All procedures strictly follow the appropriate protocols. All samples will be stored in coolers with ice. Chain-of-custody records will be kept with the samples and custody seals will be placed on the coolers.

TABLE 5-1

SAMPLE COLLECTION, PRESERVATION, AND HOLDING TIMES
OLD SILVER BOW LANDFILL ASSESSMENT OF CORRECTIVE MEASURES INVESTIGATION

MEDIA	PARAMETER	REFERENCE	PRESERVATION	HOLDING TIME	SAMPLE SIZE	BOTTLE
Solid	Fertilizer Recommendation Analysis (N,K,P)	N - ASA #9 (84-2); K - ASA #9 (71-3); P - ASA #9 (73-4.1)	Ice to 4°C	N/A	8 oz.	8 oz.
Solid	Soil Texture	USDA Handbook #18	N/A	N/A	N/A	N/A
Solid	Hydraulic Conductivity	ASTM D5084, Method C	N/A	N/A	12" length, 2" dia. auger	Plastic sleeve
Solid	Organic Matter Content	ASA #9, Part 2 (90) pgs. 1371-1372	N/A	N/A	4 oz.	1 qt. ziplock storage bags
Solid	Atterberg Limits	ASTM D4318	N/A	N/A	4 oz.	1 qt. ziplock storage bags
Solid	Bulk Density (In-Place) **	ASTM D420	N/A	N/A	12 in. length 2 in. dia..	Plastic Sleeve
Solid	Moisture Content	CLP SOW 3/92	N/A	N/A	4 oz.	1 qt. ziplock storage bags
Solid	Standard Proctor	ASTM D 698 and D 2049	N/A	N/A	25 lbs.	5 gal. bucket
Solid	Particle size	ASTM D 422	None	None	4 oz.	4 oz.
Solid	Cation exchange capacity	EPA 9081 (SW-846)	None	7 days until drying; 8 mos. after drying	4 oz.	4 oz.
Water	Dissolved Metals	CLP SOW 3/92	Filter, HNO_3 to pH <2	180 days; Hg 28 days	1 L	1 L Poly
Water	Cyanide	CLP SOW 3/92	NaOH to pH>12; Ice to 4°C	12 days	1 L	1 L Poly
Water	Sulfate***	EPA Method 9038 (SW-846) or 375.1 (CAWW)	Ice to 4°C	28 days	1 L	1 L Poly
Water	Nitrate/Nitrite-N	EPA Method 353.2 (CAWW)	H_2SO_4 to pH <2; Ice to 4°C	28 days	250 ml	250 ml Poly
Water	Chloride***	EPA Method 325.1 or 325.3 (CAWW)	Ice to 4°C	28 days	1 L	1 L Poly
Water	Sulfide	EPA Method 9030 (SW-846)	Zinc acetate/NaOH	28 days	1 L	1 L Poly

TABLE 5-1 (cont'd.)

SAMPLE COLLECTION, PRESERVATION, AND HOLDING TIMES
OLD SILVER BOW LANDFILL ASSESSMENT OF CORRECTIVE MEASURES INVESTIGATION

MEDIA	PARAMETER	REFERENCE	PRESERVATION	HOLDING TIME	SAMPLE SIZE	BOTTLE
Water	Volatile Organic Compounds	EPA Method 8260 (SW-846)	HCl to pH<2	14 days	40 ml	(2) 40 ml glass vials
Water	Semi-volatile organics	EPA Method 8270 (SW-846)	Ice to 4°C	7 days to extract; 40 days to analyze	1 L	1 L glass
Water	Organochlorine pesticides and PCBs	EPA Method 8081 (SW-846)	Ice to 4°C	7 days to extract; 40 days to analyze	1 L	1 L glass
Water	Chlorinated Acids	EPA Method 8151 (SW-846)	Ice to 4°C	7 days to extract; 40 days to analyze	1 L	1 L glass
Gas	Volatile Organic Compounds	EPA Method 8260 (SW-846)	Ice to 4°C	14 days	1 L	Tedlar bag

** - This lab method will be used if a field nuclear density gauge (ASTM D2922) is not used.
*** - Chloride and Sulfate can be analyzed from the same 1 L Poly bottle.
CAWW - Methods for Chemical Analysis of Water and Wastes (EPA, 1984).
SW-846 - Test Methods for Evaluating Solid Waste-Physical/Chemical Methods, SW-846 (EPA, 1986).
ASTM - American Society for Testing and Materials (ASTM, 1985).
ASA #9 - American Society of Agronomy, Methods of Soil Analysis (ASA, 1965).

5.1.4 Documentation

All field sampling activities and non-sampling data collection will be recorded in the site log book, this includes information on weather conditions, field crew members, visitors to the site, samples collected, the date and time of sample collection, procedures used, any field data collected, and any deviations from this plan.

5.1.5 Post-sampling Activities

All personnel must go through decontamination procedures when leaving a contaminated area for their own protection. Personnel decontamination includes routine practices as well as emergency decontamination; all procedures follow EPA protocols. All measures will be taken to prevent the spread of potentially hazardous materials to clean areas. All potentially contaminated fluids, sampling equipment, and personal protective materials generated on-site will be containerized and disposed of properly. All wastes will be managed according to Office of Emergency and Remedial Response (OERR) Directive 9345.3-02 "Management of Investigation Derived Wastes During Site Inspections" (EPA, 1991).

All samples will be either hand-delivered or shipped via Federal Express to the laboratories under strict EPA chain-of-custody. Samples will be shipped in coolers, which will be kept cool with ice and insulated with appropriate packing material; this will prevent detrimental effects from possible sample container leakage. Custody seals will protect the integrity of the samples while in transit to the laboratory.

5.2 QA/QC SAMPLING

5.2.1 Groundwater QA/QC Sampling

Groundwater QA/QC samples to be collected will include field blank and duplicate samples. Equipment rinsate samples will not be collected due to the use of pre-cleaned, disposable water sampling equipment and dedicated sampling bailers.

Field blank samples will be collected at a minimum frequency of 1:20. Field blank samples will be prepared for VOC (EPA Method 8260) analysis and metals analysis. The metals field blank is generated by pouring purified (ASTM Type II, metals free) water directly into the sample containers while in the field. The VOC field blank is prepared by pouring HPLC grade water directly into VOC sample containers. Blank samples will be preserved in the same manner as the groundwater samples. These field blank samples check the quality of the laboratory data and cleanliness of the sample containers and preservatives.

Duplicate samples will be collected at a minimum frequency of 1:20. Duplicate samples will be collected and analyzed for the full suite of analyses conducted for the field samples. Duplicate samples will serve as a check of the reproducibility and accuracy of the lab data and sampling procedure.

5.2.2 Soil Gas QA/QC Sampling

Soil gas analyses will be conducted in the field with a portable gas chromatograph. Analytes will be limited to tetrachloroethene; trichloroethene; cis-1,2-dichloroethene; vinyl chloride; and chloroethane. Quality assurance split samples will be collected at a minimum frequency of 1 split for each 5 samples in which VOCs are detected with the field instrumentation. A minimum of two split samples will be submitted regardless of the field analytical results. These split samples will be collected in a Tedlar bag supplied by the analytical laboratory. The split samples will be analyzed for the full suite of VOCs via EPA Method 8260.

6.0 PROJECT MANAGEMENT/PERSONNEL

Project Manager/Project Engineer - Brad Archibald, Pioneer

Assists in field activities and documents activities in the site log book. Responsible for equipment, problem solving, and decision-making in the field. Ensures that work crews comply with all site health and safety requirements.

Field Team Leader/Quality Assurance Manager - Shawn Bisch, Pioneer

Assists in field activities and documents activities in the site log book. Responsible for equipment, problem solving, and decision-making in the field. Ensures that work crews comply with all site health and safety requirements. The Quality Assurance Manager will be the leader of the data review, validation, and evaluation, and auditing requirements.

Field Team Samplers - Field Team Samplers may include Dave Tuesday, Bill Bullock, Julie Flammang, Dawn Clark, Doug Richmond, Greg Liebelt, Pat Sampson, Steve Pierce, and Meg Babits, Pioneer. Responsible for implementation of the sampling procedures, sample custody, field equipment operation, maintenance, calibration, and standardization.

Geoprobe and soil gas survey services will be provided by Atlatl, Inc. Joe McElroy will be Atlatl's representative and will be responsible for equipment and implementing sampling procedures associated with the installation of geoprobe borings; collection of soil, soil gas, and groundwater samples from the geoprobe borings; and on-site analysis of soil gas samples via gas chromatograph.

7.0 SCHEDULE

Most activities for the Assessment of Corrective Measures Investigation should be completed in late 1995 and spring early 1996. The on-going groundwater assessment and/or detection monitoring described herein will continue through the post-closure period of the landfill as required by ARM 16.14.706(4).

Once sampling activities have been completed and analytical data have been received, a report detailing the investigation findings will be prepared. This information will then be considered in the detailed analysis of corrective measures report.

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APPENDIX A

STANDARD OPERATING PROCEDURES

PTS-SOP-GW-01

STANDARD OPERATING PROCEDURES
ELEVATION SURVEY FOR MONITOR WELLS

1. Arrive at the site with appropriate equipment in good working condition.

2. Begin survey using a USGS elevation reference mark as a reference point. If none are available, establish an arbitrary reference point. The arbitrary reference point must be a solid fixed point that will not change throughout the project.

3. Record survey instrument readings in field note book using proper notation.

4. Survey all monitor well locations with an accuracy of ±0.01 foot.

5. Measure three elevations for each well including:

    a. top of the inner well casing (TOC);
    b. top of the outer protective casing (on the lip, not the cap); and
    c. finished concrete pad adjacent to the outer well casing.

6. Mark TOC for future water level measurements.

7. Return survey circuit to point of origin to complete the loop and determine if the survey "closed" to allowable limits of precision.

PTS-SOP-GW-02

STANDARD OPERATING PROCEDURE
SAMPLING WITH A BAILER

1. Using clean, noncontaminating equipment, e.g., an electronic level indicator (avoid indicating paste), determine the water level in the well, then calculate the fluid volume in the casing.
2. Purge well by pumping or bailing until pH (PTS-SOP-FM-01), specific conductance (PTS-SOP-FM-03), and temperature (PTS-SOP-FM-04) have stabilized.
3. Attach a bottom discharging bailer to clean rope for lowering and raising.
4. Lower bailer slowly until it contacts water surface.
5. Allow bailer to sink slowly and fill with a minimum of surface disturbance.
6. Slowly raise bailer to surface. Do not allow bailer line to contact the ground surface.
7. Use bottom discharge device to slowly discharge sample into appropriate containers, or pour slowly from top of bailer.
8. Repeat Steps 2 through 5 as needed to acquire sufficient volume.
9. Preserve the sample, if necessary.
10. Check that a Teflon liner is present in cap if one is required. Secure the cap tightly.
11. Label the sample bottle with an appropriate tag. Be sure to complete the tag with necessary information. Record the information in the field logbook and complete all chain-of-custody documents.
12. Place the properly labeled sample bottle in an appropriate carrying container maintained at 4° C throughout the sampling and transportation period.
13. Bailer will be thoroughly decontaminated after each use according to SOP-DE-02.

PTS-SOP-GW-03

STANDARD OPERATING PROCEDURE
DEPTH TO WATER LEVEL MEASUREMENTS

1. Arrive at site with proper equipment, fully decontaminated and in working order.

2. Place water level indicator down the well and measure depth using the measure point marked on the well casing.

3. If using chalked tape, coat the lower three to five feet of tape with chalk and lower into well. Listen for weight to contact water and lower tape an additional 0.5 foot. Record measure point and pull tape carefully from well. Read the wetted chalk mark and record. Subtract the wetted chalk mark from the measure point for true depth to water.

4. Decontaminate all equipment before re-use.

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF pH & EH IN WATER

Field Procedures

1. Rinse beaker with sample water three times.

2. Rinse pH and temperature probes with deionized water.

3. Fill beaker with sample water.

4. Turn on meter and immerse pH probe and temperature electrodes in sample water. Stir sample for thorough mixing. Read and record pH to nearest 0.01 unit once pH reading has stabilized.

5. Rinse electrodes with deionized water and store in carrying case.

Note: pH may also be measured by placing the probe directly into the water body being tested. The probe must be moved slowly in a circular motion when measuring stagnant water.

Instrument Calibration

Calibrate pH meter in the field at the beginning of each day of field work and when the standard check is out of calibration. Recheck calibration at end of day.

1. Rinse pH and temperature probes in deionized water.

2. Turn on meter and immerse pH and temperature probe in a pH 7 buffer solution. Calibrate meter to pH 7 allowing enough time for meter to stabilize.

3. Rinse pH and temperature probe with deionized water.

4. Immerse pH and temperature probe in either a pH 4 or a pH 10 buffer solution depending on whether expected pH of samples is above or below pH 7. If expected sample pH is above pH 7, use pH 10 solution for the second calibration. If expected sample pH is below pH 7, use pH 4 for the second calibration. Calibrate meter to second pH solution allowing enough time for meter to stabilize.

5. Rinse pH and temperature probe with deionized water.

6. Recheck meter calibration to a pH 7 calibration solution. Repeat the calibration process (Steps 2-4) if value for final pH check is more than 0.1 units from pH 7.0.

Redox-Potential (EH) Measurements

EH measurements are performed using ORION model 96-78 redox electrode and ORION SA-210 or 250A portable meter set to the millivolt (mV) mode.

Filling Electrode:

The electrode shall be filled with one of the two solutions selected to best match the ionic strength of the sample solution to minimize junction potentials. The following solutions shall be used:

1. Dilute solution [total ionic strength less than 0.2 molar (M)]. Use ORION dilute filling solution (Cat. No. 900001), which will match the potential of a conventional calomel electrode.
2. Concentrated solution (total ionic strength greater than 0.2M). Use ORION concentrated filling solution (Cat. No. 900011), which is 4M KCl saturated with Ag/AgCl.

Filling solution level in the electrode should always be at least one inch above the level of the solution being measured.

Connecting the Electrode to the Meter:

Insert the platinum redox connector (large diameter) in the pH or sensing electrode input jack on the ORION SA-210 meter and the reference electrode connector (small diameter) into the reference electrode input jack.

Calibration Procedure:

The meter shall be calibrated daily using a two stage process that checks the operation and accuracy of the meter. To check the operation of the meter:

1. Connect the electrodes to the meter, place the electrodes in a beaker of tap water, and turn on the meter.
2. Add a drop of dilute NaOH to the beaker and mix it with tap water.
3. If the reading on the meter decreases sharply, then the electrodes are sensitive and operating properly.
4. If little or no change in the reading is observed, then the electrodes are not functioning properly and must be cleaned. The following summarizes the electrode cleaning procedures:

    - Drain filling solution from outer portion of electrode body and refill with fresh solution (see Filling Electrode).

- If the electrode still does not function properly, remove sleeve from the inner electrode, rinse all the parts of the electrode with DS/DI water, and allow to air dry.

- Reassemble electrode and refill with filling solution.

To check the accuracy of the meter and EH electrode:

5. Use a standard solution consisting of Zobell's ferrous/ferric solution.

6. Rinse electrodes with DS/DI water.

7. Pour the standard solution into a small beaker and place electrodes into the beaker. The redox potential of the standard solution should read 439 +/- 30 mV. If the reading deviates from this range, then the electrodes must be cleaned (see Step 4).

Measurement Procedure

1. Set the mode switch to the mV position, and place the electrode in the sample solution. When the reading stabilizes, record the potential.

2. For some applications, redox-potential readings are reported relative to the normal hydrogen electrode (NHE). To do this, select the electrode potential (C) value in Table FM-01-1 that corresponds to the filling solution used and the temperature of the solution measured. Substitute the table value for C in the following equation and solve for E.

   $E = E_o + C$ where:

   E - Oxidation reduction potential of the sample relative to the NHE.

   E_o - Potential developed by the platinum redox electrode.

   C - Potential developed by the reference electrode relative to the NHE (see Table FM-01-1).

TABLE FM-01-1

POTENTIALS ("C") DEVELOPED BY THE REFERENCE ELECTRODE PORTION RELATIVE TO THE NORMAL ELECTRODE AT VARIOUS TEMPERATURES

	"C" electrode Potential in mV	
Temperature °C	900001 Solution	900011 Solution
10	251	214
20	244	204
25	241	199
30	238	194

PTS-SOP-FM-02

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF pH IN SOIL

METHOD 1:

Materials Required

1. Orion pH meter [refer to Standard Operating Procedure PTS-SOP-FM-01 for calibration and operating procedures]
2. pH probes and pH-4, pH-7, and pH-10 buffer solutions
3. Hard plastic spoons (teaspoon size, two minimum)
4. Glass stirring rods (two minimum)
5. 50-milliliter (ml) sample beaker (or disposable cup) with lid. Quantity depends on number of samples
6. Deionized (DI) water (two liters minimum)
7. 0.01 M $CaCl_2$ (1.47 grams $CaCl_2$ x 2 H_2O/liter = 2 liters minimum)
8. Paper towels

Field Laboratory Procedures

1. Place approximately 1 teaspoon (about 10 grams) of soil sample in sample beaker.
2. Add about 20 ml of 0.01 M $CaCl_2$ into beaker.
3. Stir with glass rod to make slurry. (Clean glass rod with DI water prior to preparing another soil sample.)
4. Attach lid to beaker and shake vigorously.
5. Let beaker stand until sediment has settled. (This will take about 5 minutes for sandy samples to 30 minutes for clayey samples.)
6. Calibrate pH meter according to procedures outlined in SOP-FM-01.
7. Immerse clean pH probe in the supernatant. Gently move the probe up and down without disturbing the sediment.

8. Record pH value of solution in the field log book when stabilized.

9. Decontaminate pH probe and continue on to next sample.

METHOD 2:

Materials Required

1. Soiltest direct reading soil pH meter

2. Deionized (DI) water

3. Paper towels

Field Laboratory Procedures

1. Place decontaminated pH tester into soil, assuring maximum contact of metal side plates in finer grained soil. Note that soil must be damp for this procedure to give proper results.

2. Read pH from face of meter after equilibration (approximately 10 seconds. If dial does not move, soil is not damp enough for testing. Use another, wetter aliquot, add a small amount of tap water to the soil, or use METHOD 1 ($CaCl_2$)

3. Record pH value of soil in the field log book.

4. Decontaminate pH probe and continue on to next sample.

PTS-SOP-FM-03

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF SPECIFIC CONDUCTANCE

Field Procedures

1. Calibrate instrument as described in instruction manual. Usually the lowest concentration standard is appropriate. Recalibrate at the end of the day and note any drift. Replace batteries and try fresh calibration solutions if meter does not calibrate properly.
2. Rinse decontaminated beaker with sample water three times.
3. Fill beaker with water sample.
4. Rinse conductivity probe with deionized water and place probe in sample water.
5. Submerge conductivity probe in sample so that flow cell holes are immersed, stir to remove any air bubbles from within flow cell. Turn instrument on to appropriate scale for sample analysis. Read specific conductance and record to the nearest one Seimen (same as micromhos/centimeter). Measure sample temperature to the nearest 0.1 °C from conductivity meter after temperature has equilibrated.
6. Remove probe from sample and rinse with deionized water.
7. Correct conductivity reading to specific conductance (corrected to 25° C) by multiplying the conductivity value by the temperature correction factor and then by the probe correction factor (unless SC unit has an automatic temperature correction).

Maintenance

1. Store meter in case during transport.
2. Check batteries before taking meter into the field. Carry spare batteries and deionized water for rinsing probe.
3. Inspect probe for damage or dirt.
4. If meter readings are erratic, return meter and probe to factory for repair.

PTS-SOP-FM-04

STANDARD OPERATING PROCEDURE
FIELD MEASUREMENT OF WATER TEMPERATURE

NOTE: Often, temperature is measured with a pH meter or the Specific conductance meter. If included as part of those instruments, use SOP for that instrument. Otherwise:

1. Provide two calibrated thermometers inside protective cases for field measurements.

2. Check thermometer for cracks or gaps in the mercury. If cracks or gaps are visible, thermometer will not be used.

3. When possible, measure temperature of surface water at midstream, submersing the thermometer for approximately one minute or until temperature stabilizes.

4. When in situ temperature measurements are not possible, draw sample of at least 200 milliliters into a decontaminated beaker or sample bottle as soon after sampling as possible.

5. Place thermometer in sample. Do not allow thermometer bulb to touch sides of beaker. Allow to equilibrate (about one minute).

6. Record temperature to nearest 0.5° C in field log book or on field data sheet.

7. On a quarterly basis, check field thermometers against NBS-calibrated laboratory thermometer. Agreement should be within 0.5° C.

PTS-SOP-S-03

STANDARD OPERATING PROCEDURE
SUBSURFACE SOIL SAMPLING

The need for biased sampling of subsurface soils should be evaluated by considering factors such as the precipitation, the type of soil and the length of time the site has been contaminated. If precipitation has moved contaminants into lower soil horizons, subsurface sampling may be appropriate. Subsurface sampling includes soil depths from 1 foot to 25 feet.

Subsurface sampling can also be composite or grab sampling similar to surface sampling techniques.

Shallow Subsurface Sampling

1. The hand auger may be used to collect subsurface samples up to four or five feet in depth. The auger is twisted into the soil. The auger destroys the soil's cohesive structure and stratigraphic character.

2. The in situ soil recovery auger may be used to collect subsurface samples up to five feet. The auger accommodates a liner and provides fast cutting of the soil with very little soil disturbance.

Deep Subsurface Sampling

1. A power auger mounted on a truck or trailer, a well drilling rig, or a backhoe can be used for sampling up to 25 feet or more in depth.

In order to analyze for hydraulic conductivity, an in situ soil recovery auger with a plastic liner and caps will be utilized to collect subsurface soil samples. All applicable equipment for one sampling round is as follows:

- Hand bucket auger
- Auger extensions
- Pipe wrenches
- Plastic sheeting
- AMS core sampler
- Plastic retaining cylinders
- Plastic caps
- Slide hammer attachment

Utilizing the above equipment, samples will be collected in the following manner:

1. Prior to sampling, ensure that all equipment (with the exception of the plastic retaining cylinders, caps, and sheets) has been decontaminated following the guidelines outlined in PTS-SOP-DE-02.

2. Place a plastic retaining cylinder in the sampling core and tighten the core sampler cap

after a sampling location is selected by the field team leader.

3. Thread the hammer attachment to the core sampler cap and tighten to approximately 140 pounds.

   Note: If the sample is required to be taken at a depth greater than the length of the core sampler, hand auger using the bucket auger until desired depth is reached. Place the extracted soil onto plastic sheeting for analysis. Then thread extensions to the core sampler to the desired length. Then attach the sliding hammer.

4. Drive the core sampler into the soil until the cap is even with the surface of the soil or until the core sampler is full. Extract the sampler by driving upward with the hammer attachment.

5. Unthread soil sampler cap from the core sampler cap and tip upside down so the plastic retaining cylinder will slide out. Cap the ends of the retaining cylinder and label it appropriately.

6. Parafilm will be wrapped around both capped ends of the retaining cylinder and the cylinders will be wrapped in bubble wrap to ensure safety during transportation.

7. After sampling at each location, the equipment shall be decontaminated following PTS-SOP-DE-02. While cleaning, special care has to be taken to keep the vent hole in the cap free from any obstruction.

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES
Solid and Hazardous Waste Bureau
Solid Waste Program
MARC RACICOT, GOVERNOR **406/444-1430** FAX # (406) 444-149
STATE OF MONTANA
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January 28, 1994

David S. Tuesday, Principal Hydrogeologist/Geochemist
Pioneer Technical Services, Inc.
P.O. Box 3445
Butte, Montana 59702

RE: **BUTTE-SILVER BOW CLASS II LANDFILL, SILVER BOW COUNTY - LICENSE NO. 20**
REQUIRED FALL 1993 GROUND WATER SAMPLING EVENT - REVIEW AND COMMENTS ON STANDARD OPERATING PROCEDURES SUBMITTED.

Dear Mr. Tuesday:

Thank you for providing Pioneer's Standard Operating Procedures (SOPs) for ground water sampling. There are still several outstanding items that will need to be clarified/verified in writing concerning this site-specific sampling event. These items are:

1. List the background well(s) that you plan to sample at this facility and why you have chosen the particular well(s).

2. Determine the appropriate Table of parameters/constituents for which you will have the samples analyzed (i.e. Table I for an additional Detection Monitoring analysis, or Table II for the Assessment Monitoring based on only one set of Table I analytical results to date).

3. List and describe the sample blanks that you will be preparing for analysis. At a minimum (assuming you are using a bailer that will be decontaminated between wells both for purging and for sampling, as PTS-SOP-GW-10 implies) the sample blanks should include the following:

* A Trip Blank - for volatile organic compounds (VOCs), prepared from de-ionized water from the laboratory. The purpose of the trip blank is to accompany the sample containers which includes, shipment of the containers to the site, on-site sampling, as well as in transport back to the laboratory for analysis. If the laboratory is agreeable to holding this sample until results from the sampling event can be determined and the trip blank sample holding time has not been exceeded, the analysis of this sample blank may be deferred, and may even be omitted if no VOC anomalies are detected in the other samples and sample blanks.

*An Equipment Blank - should consist of a full sampling suite. The equipment blank consists of the rinsate water from decontamination of the sampling equipment between wells (i.e. in this case, the sampling bailer).

* A Duplicate Sample (complete suite of samples) from one of the down gradient monitoring wells.

4. From the existing ground water monitoring wells at this facility, please provide a list of the wells that you will be sampling. Include the background well(s) in this list, and prepare the list in the order in which the wells will be sampled in the field.

Specific comments concerning Pioneer's SOPs that were submitted to the Department for this sampling event at the old Butte/Silver Bow Class II Landfill, are as follows:

A. PTS-SOP-DE-01

#1. There is no "Site Safety Plan" at this facility yet. It will be required in the final site specific Sampling and Analysis Plan (SAP), once it has been adequately determined that the ground water is contaminated at this site [see Administrative Rules of Montana (ARM) 16.14.706(1)(c)].

B. PTS-SOP-DE-02

All equipment entering the site must be properly decontaminated before being brought onto this site. This issue is more explicitly addressed in PTS-SOP-GW-11.

C. PTS-SOP-FM-01

Please consider doing a headspace vapor analysis of the wells using an explosimeter, or a similar meter to measure the lower-explosive-limit (LEL) and/or percent by volume of explosive gases. This would be helpful in detecting and delineating methane gas generated in the landfill area. Note: this comment may be equally applicable to **PTS-SOP-GW-11**.

D. PTS-SOP-S-01 and PTS-SOP-S-02

No soil sampling will be required during the ground water monitoring sampling event. Why were these SOPs included?

E. PTS-SOP-GW-05

Please check well completion forms. I feel confident that these wells have been surveyed into a USGS benchmark elevation.

NOTE: Well completion forms are quite helpful when sampling ground water monitoring wells for the first time.

F. PTS-SOP-GW-10

#9. Please acknowledge that 40-ml. VOAs will be checked for air bubbles after filling.

Will individual disposable bailers be used for sampling, and/or possibly even for purging at each well? [redacted] ~~reduce the need for a full sample suite~~ equipment blank, as distilled water from decontamination rinsate water would only need to be analyzed for VOCs.

G. PTS-SOP-GW-12

Page B-18. Although ground water monitoring wells have already been installed for this sampling event, and this SOP should not be necessary, it is important to comment on Pioneer's need for a "vent hole" in the casing. If this "vent hole" is actually in the well casing, it will not be an approved completion practice. The opportunity for contaminants to enter this hole and possibly alter the natural quality of the ground water at that location is of too great a concern to permit such a hole. If I have misunderstood the intent and location of this hole, and you plan to have a small hole near the top of the protective outer steel casing, the Department has no serious concern about that. Please let me know where this intended "vent hole" would be placed, in the event that Pioneer should do any ground water monitoring well constructions in the future which would involve the Solid Waste Program.

Be sure to notify the Department at least several days prior to conducting the ground water sampling event, so that the Department may be present on-site to observe sampling procedure and collect split-samples, as necessary [ARM 16.14.706(a)(iv)(G)].

The Department will require a brief written response concerning all of the above items, so that approval can be given and the Fall 1993 ground water sampling event conducted as soon as possible.

Sincerely,

Pat Potts

Pat Potts
Environmental Specialist

cc: Jim Johnston, Director of Public Works, Department of Public Works, Courthouse, Butte, MT 59701

Gary Keeler, Department of Public Works, (as above)

Butte-Silver Bow County Commissioners, 155 West Granite Street, Butte, MT 59701

Dan Powers R.S., Butte-Silver Bow County Sanitarians, 25 West Front Street, Butte, MT 59701

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File Copy

PIONEER
TECHNICAL SERVICES, INC.
P.O. BOX 3445, BUTTE, MONTANA 59702 PHONE (406) 494-4024 FAX (406) 494-148

January 31, 199~~3~~4

Ms. Pat Potts
MDHES Solid Waste Program
Cogswell Building
Helena, Montana 59620

RE: Comments on Pioneer's SOP's

Dear Ms. Potts:

Enclosed are my brief written responses to your comments regarding Pioneer's sampling at the Old Butte Landfill and corporate SOP's. Since these SOP's are general in nature, they do not address site-specific issues or procedures that are unique to the Old Butte-Silver Bow Class II Landfill.

Comment #1, Background well(s): Any of the three MBMG wells northwest of the landfill could be used as a background, as could well BSB-A4. I prefer not to use well BSB-A4 as it appears to be downgradient from a small portion of the landfill area, even though no contaminants were detected in the first sampling. The three MBMG wells are located hydraulically upgradient from the landfill, based on the groundwater flow map prepared by SRM. Of the three wells, I have selected MBMG #2 based on the completion specifications. It was drilled deeper than MBMG #1 by 4 feet (17 ft. vs. 21 ft.) and has 10 feet of screened interval rather than 5 feet. MBMG #2 is a 2-inch i.d. monitoring well, while MBMG #3 is a 4-inch i.d. well; the 2-inch well will require significantly less well purging volume (and time) than the 4-inch well. Therefore, I propose to use MBMG #2 as the background well for this sampling.

Comment #2, Table of analytical constituents: Upon review, the County has determined that Table 1 - Detection Monitoring suit should be analyzed at this time.

Comment #3, QA/QC Samples for analysis: Both a VOC trip blank sample and a duplicate sample (entire suite of analyses) will be collected for analysis. Probably well BSB-A2 will be used for the duplicate. An equipment rinsate from the decontaminated bailer may be collected if there are not dedicated bailers for each well; if there are dedicated bailers, as described in the SRM sampling plan, no rinsate sample will be collected. It would be more cost effective to purchase the bailers and dedicate one to each well, rather than submit a rinsate sample for an expensive analysis.

Comment #4, List of wells to be sampled and order: First, the

100% post-consumer paper & 100% vegetable based inks

background well, MBMG #2 will be sampled (cleanest). Then BSB-A4, BSB-A3, BSB-A1, and BSB-A2 (and duplicate) will be collected. This order is roughly from the cleanest well (A4) to the most contaminated well(A2) and considers access and proximity.

SOP Comment A, PTS-SOP-DE-01: Pioneer will follow our Corporate Health and Safety Plan as it applies to landfill sites.

SOP Comment B, PTS-SOP-DE-02: All equipment will arrive at the site decontaminated to avoid transporting any off-site contaminants to the site. Equipment used will be decontaminated prior to leaving the site to avoid transporting any contaminants off the site.

SOP Comment C, PTS-SOP-FM-01: Pioneer does not currently have an explosimeter available; we measure headspace with a photoionization detector (MicroTIP). If these measurements are important, Pioneer can rent an explosimeter for the sampling.

SOP Comment D, PTS-SOP-S-01 and S-02: Soil sampling will not be done for this round of sampling, but in the event that Pioneer is involved in the drilling of additional wells, soil sampling will be performed. I wanted you to have a complete set of SOP's (same for PTS-SOP-GW-12).

SOP Comment E, PTS-SOP-GW-05: I have reviewed the well completion forms and they include a surveyed elevation; this work will not be repeated. The surveying portion of the SOP only applies to previously unsurveyed wells.

SOP Comment F, PTS-SOP-GW-10: The 40-ml VOA vials will be checked for trapped air bubbles by inverting the vial and tapping. If bubbles are found, the sample will be discarded and resampled.

SOP Comment G, PTS-SOP-GW-12: See response above regarding why this SOP was included. The "vent hole" described is a small hole in the outer steel casing that allows any water spilled between the inner and outer casings to drain away. This hole is usually at the annular sealant level between the two casings, which is above ground level, but lower than the top of the casing. It would more correctly be called a drain hole. If this hole poses a problem, it can easily be deleted from the SOP.

Thank you for your review. I hope these responses will clarify the issues you raised. If you have any questions, comments or suggestions, please don't hesitate to call me at 782-5177.

Sincerely,

David S. Tuesday
Principal Hydrogeologist/Geochemist

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES
Solid and Hazardous Waste Bureau
Solid Waste Program
MARC RACICOT, GOVERNOR 406/444-1430 FAX # (406) 444-1499
STATE OF MONTANA
OFFICE LOCATION 836 Front Street Helena, Montana
MAILING ADDRESS: PO BOX 200901 Helena, MT 59620-0901

February 2, 1994

David S. Tuesday, Principal Hydrogeologist/Geochemist
Pioneer Technical Services, Inc.
P.O. Box 3445
Butte, Montana 59702

RE: **BUTTE-SILVER BOW CLASS II LANDFILL, SILVER BOW COUNTY - LICENSE NO. 20**
APPROVAL FOR FALL 1993 GROUND WATER SAMPLING EVENT.

Dear Mr. Tuesday:

Thank you for the timely, concise response to my letter dated January 28, 1994 concerning questions, comments, and concerns I had about the Standard Operating Procedures (SOPs) submitted to the Department in conjunction with the proposed Fall 1993 ground water sampling event to be conducted at the Old Butte-Silver Bow Class II Landfill. The Department approves Pioneer's SOPs which were submitted with a cover letter dated January 18, 1994, along with the additional letter of responses dated January 31, 1994.

Please consider including dichlorodifluoromethane to the list of required volatile organic compounds in the Administrative Rules of Montana (ARM) 16.14.706 Table 1.

Sincerely,

Pat Potts

Pat Potts
Environmental Specialist
cc: Jim Johnston, Director of Public Works, Department of Public Works, Courthouse, Butte, MT 59701
Gary Keeler, Department of Public Works (As above)
Butte-Silver Bow County Commissioners, 155 West Granite Street, Butte, MT 59701
Dan Powers, R.S., 25 West Front Street, Butte, MT 59701
path: sw\silbut.app file: silver bow co/old butte/grd wtr

APPENDIX B

STATISTICAL SUMMARY OF EXISTING GROUNDWATER DATA

SILVER BOW COUNTY -OLD LANDFILL GROUNDWATER DATA SUMMARY
INORGANIC CONSTITUENTS (ug/L)
NOVEMBER 30, 1995

	STANDARDS		MBMG-2		BSB-A1		BSB-A2		BSB-A3		BSB-A4		Mean Exceeds	Median Exceeds	BLANK		LAB
	USEPA MCL*	MT HHS	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Std. or Bkd.	Std. or Bkd.	Mean	Median	MDL
Ag	100(s)	- -	0.1	0.1	0.1	0.1	0.8	0.1	0.8	0.1	0.1	0.1	None	None	0.1	0.1	0.21
As	50	18	4	2	2	2	9	10	35	39	3	3	None	None	1	1	1.2
Ba	2,000	1,000	132	133	92	81	69	75	160	174	35	32	None	None	4	2	3
Be	4	40	1	1	1	1	1	1	1	1	1	1	None	None	0.5	0.5	1.6
Cd	5	5	0.2	0.2	0.2	0.2	**20.2**	**6.2**	0.8	0.1	0.1	0.03	A2 (std)	A2 (std)	0.03	0.03	0.054
Co	- -	- -	4	4	4	4	**18**	**20**	7	4	4	4	A2 (bkd)	A2 (bkd)	4	4	8.5
Cr	100	100	5	4	4	4	5	4	4	4	4	4	None	None	4	4	8
Cu	1,300(a)	1,000	3	2	2	2	2	2	2	2	3	2	None	None	2	2	3.3
Fe	300(s)	300	84	55	29	24	**6,332**	**6,965**	**76,630**	**81,550**	21	9	A2,A3 (std)	A2,A3 (std)	9	9	18
Hg	2	0.14	0.08	0.05	0.09	0.05	0.06	0.05	0.14	0.12	0.14	0.12	None	None	0.05	0.05	0.097
Ni	100	100	7	7	7	7	27	14	7	7	7	7	None	None	7	7	14.2
Pb	15(a)	15	0.8	0.5	1.0	0.5	0.5	0.5	0.5	0.5	0.8	0.5	None	None	0.5	0.5	0.91
Sb	6	14	4	4	3	2	3	4	2	2	3	3	None (blk)	None (blk)	**8**	**10**	2.1
Se	50	50	0.5	0.4	0.7	0.4	0.4	0.4	0.7	0.4	1.4	0.7	None	None	0.4	0.4	0.82
Tl	2	1.7	**5**	**6**	**5**	**5**	**6**	**6**	**9**	**8**	**4**	**5**	All (std)	All (std)	1	1	1.14
V	- -	- -	10	10	3	3	3	3	3	3	6	7	None	None	3	3	5.2
Zn	5,000(s)	5,000	13	5	12	12	**9,637**	4,870	224	102	10	5	A2 (std)	None	6	5	9.5
Chloride	250,000(s)	- -	59,200	57,000	16,000	15,000	125,000	123,000	44,830	44,000	9,333	7,500	None	None	- -	- -	5000
Sulfate	250,000(s)	- -	129,800	134,000	116,000	101,500	**304,200**	247,000	65,670	50,000	163,800	159,000	A2 (std)	None	- -	- -	5000
Nitrate	10,000	- -	5,158	5,170	508	620	51	38	33	25	972	1,005	None	None	- -	- -	50
COD	- -	- -	79,900	48,000	70,170	45,500	194,000	175,000	103,500	93,000	22,750	19,000	None	None	- -	- -	5000
SC	- -	- -	699	700	502	462	**1,708**	**1,650**	**1,113**	**1,125**	604	583	A2,A3(bkd)	A2,A3(bkd)	- -	- -	- -

* MCL definitions: a = action level, not an MCL; s = secondary MCL (asthetics)
BDL values calculated as equal to one half the method detection limit (MDL)
Bolded values exceed established standards (significantly above background for constituents with no standard)

SILVER BOW COUNTY -OLD LANDFILL GROUNDWATER DATA SUMMARY
ORGANIC CONSTITUENTS (ug/L)
NOVEMBER 30, 1995

	STANDARDS		MBMG-2		BSB-A1		BSB-A2		BSB-A3		BSB-A4		Mean Exceeds Std. or Bkd	Median Exceeds Std. or Bkd.	BLANK		LAB MDL
	MCL	HHS	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median			Mean	Median	
Acetone	- -	- -	11.8	1.65	14.0	1.65	1.65	1.65	34.3	1.65	1.93	1.65	None	None	11.0	1.65	3.3
Benzene	5	12	0.03	0.03	0.05	0.03	1.35	1.45	2.63	2.75	0.03	0.03	None	None	0.03	0.03	0.05
Carbon Disulfide	- -	- -	0.61	0.75	0.27	0.05	0.31	0.08	0.28	0.05	3.68	2.05	None	None	0.13	0.05	0.09
Chloroethane	- -	- -	0.05	0.05	0.05	0.05	0.05	0.05	**0.79**	**0.98**	0.05	0.05	A3 (bkd)	A3 (bkd)	0.05	0.05	0.1
Chloroform	- -	57	0.83	0.81	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	None	None	0.05	0.05	0.09
Chloromethane	- -	- -	0.04	0.04	0.17	0.04	0.37	0.04	0.04	0.04	0.14	0.04	None	None	0.33	0.04	0.08
1,2-Dichlorobenzene	600	600	0.09	0.09	0.09	0.09	0.19	0.09	0.09	0.09	0.09	0.09	None	None	0.09	0.09	0.17
1,4-Dichlorobenzene-8260	75	75	0.06	0.06	0.06	0.06	3.77	4.05	3.93	4.25	0.06	0.06	None	None	0.06	0.06	0.12
Dichlorodifluoromethane	- -	6900	0.04	0.04	0.06	0.04	21.2	21.5	4.81	1.55	0.04	0.04	None	None	0.04	0.04	0.08
Dichlorofluoromethane	- -	- -	0.10	0.10	0.10	0.10	2.58	0.10	0.23	0.10	0.10	0.10	None	None	0.10	0.10	0.2
1,1-Dichloroethane	- -	- -	0.05	0.05	0.05	0.05	**11.9**	**12.5**	1.04	1.10	0.05	0.05	A2 (bkd)	A2 (bkd)	0.05	0.05	0.09
1,2-Dichloroethane	5	3.8	0.06	0.06	0.25	0.06	2.06	1.90	0.60	0.06	0.45	0.06	None	None	0.83	0.06	0.11
1,1-Dichloroethene	7	5.7	0.02	0.02	0.02	0.02	0.41	0.51	0.02	0.02	0.02	0.02	None	None	0.02	0.02	0.04
cis-1,2-Dichloroethene	70	70	0.05	0.05	0.26	0.16	**153**	**158**	46.2	45.5	0.06	0.05	A2 (std)	A2 (std)	0.05	0.05	0.09
trans-1,2-Dichloroethene	100	100	0.02	0.02	0.02	0.02	1.36	1.40	0.15	0.14	0.02	0.02	None	None	0.02	0.02	0.04
1,2-Dichloropropane	5	0.52	0.08	0.08	0.08	0.08	2.12	2.25	0.08	0.08	0.08	0.08	None	None	0.08	0.08	0.16
Ethylbenzene	700	700	0.04	0.04	0.04	0.04	0.04	0.04	2.16	1.65	0.04	0.04	None	None	0.04	0.04	0.08
Methyl Ethyl Ketone	- -	- -	2.48	2.48	2.48	2.48	2.48	2.48	13.7	2.48	2.48	2.48	None	None	2.48	2.48	4.95
Methyl Isobutyl Ketone	- -	- -	0.95	0.95	0.95	0.95	0.95	0.95	1.18	0.95	0.95	0.95	None	None	0.95	0.95	1.89
Methylene Chloride	5	47	0.03	0.03	0.03	0.03	1.51	1.70	0.03	0.03	0.03	0.03	None	None	9.36	0.03	0.06
Tetrachloroethene	5	8	0.04	0.04	1.35	1.18	**6.68**	**6.65**	0.16	0.04	0.04	0.04	A2 (std)	A2 (std)	0.04	0.04	0.08
1,1,1-Trichloroethane	200	2000	0.02	0.02	0.02	0.02	1.48	0.02	0.63	0.02	0.02	0.02	None	None	0.02	0.02	0.03
Toluene	1000	1000	0.05	0.05	0.14	0.05	0.05	0.05	0.63	0.11	0.09	0.05	None	None	0.11	0.05	0.1
Trichloroethene	5	27	0.06	0.06	0.28	0.23	**14.7**	**14.5**	1.30	1.25	0.06	0.06	A2 (std)	A2 (std)	0.06	0.06	0.12
Trichlorofluoromethane	- -	10000	0.07	0.07	0.09	0.07	0.07	0.07	0.07	0.07	0.07	0.07	None	None	0.06	0.07	0.14
Vinyl Chloride	2	20	0.15	0.15	0.15	0.15	**2.62**	**3.70**	0.69	0.68	0.15	0.15	A2 (std)	A2 (std)	0.14	0.15	0.3
m+p Xylenes	10000	10000	0.07	0.07	0.07	0.07	0.07	0.07	0.95	0.93	0.07	0.07	None	None	0.07	0.07	0.14
o-Xylene	10000	10000	0.04	0.04	0.04	0.04	0.04	0.04	0.16	0.14	0.04	0.04	None	None	0.03	0.04	0.07
1,4-Dichlorobenzene-8270	75	75	0.64	0.64	0.64	0.64	2.68	2.80	2.44	2.30	0.64	0.64	None	None	0.64	0.64	1.27
Diethylphthalate	- -	23000	0.37	0.37	0.37	0.37	4.64	2.40	1.57	1.40	0.37	0.37	None	None	0.37	0.37	0.73
Di-n-butylphthalate	- -	2700	0.29	0.29	0.29	0.29	0.37	0.29	0.33	0.29	0.29	0.29	None	None	0.29	0.29	0.57
bis(2-ethylhexyl)phthalate	6	18	0.39	0.39	0.95	0.39	0.87	0.79	0.39	0.39	1.34	0.39	None	None	0.39	0.39	0.77
Acenaphthene	- -	20	0.29	0.29	0.29	0.29	0.29	0.29	0.34	0.29	0.29	0.29	None	None	0.29	0.29	0.58
2-Methylphenol	- -	- -	0.37	0.37	0.37	0.37	0.37	0.37	12.70	0.37	0.37	0.37	None	None	0.37	0.37	0.73
4-Methylphenol/3-Methylphenol	- -	- -	0.30	0.30	0.30	0.30	0.30	0.30	0.46	0.30	0.30	0.30	None	None	0.30	0.30	0.60
Phenol	- -	300	0.34	0.34	0.34	0.34	0.34	0.34	1.77	0.34	0.34	0.34	None	None	0.34	0.34	0.67

BDL values calculated as equal to one-half the method detection limit (MDL)

Bolded values exceed established standards (significantly above background for constituents with no standard)

TABLE I: ANALYTICAL DATA FOR GROUNDWATER AND QA/QC SAMPLES, OLD SILVER BOW COUNTY LANDFILL
DATE SAMPLED: AUGUST 2, 1995

SAMPLE NUMBER	BSB-GW-01	BSB-GW-02	BSB-GW-03	BSB-GW-04	BSB-GW-05	BSB-GW-06	BSB-GW-07	DRINKING WATER MCL/MCLG
WELL	MBMG-2	BSB-A1	BSB-A5	BSB-A4	BSB-A3	BSB-A2	FIELD BLANK (Not Filtered)	
ANALYTE (units):								
DISSOLVED METALS (mg/L)								
Antimony	<0.002	0.002	0.002	0.002	0.002	0.004	<0.002	0.006 / 0.006
rsenic	0.010	0.002	0.002	0.003	0.036	0.008	<0.001	0.05
arium	0.117	0.076	0.028	0.027	0.229	0.074	<0.005	2 / 2
eryllium	0.0002	0.0003	0.0004	0.0003	0.0002	0.0002	0.0001	0.004 / 0.004
Cadmium	0.0002	0.0002	<0.0001	<0.0001	<0.0001	0.083	<0.0001	0.005 / 0.005
Chromium	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.1 / 0.1
Cobalt	<0.01	<0.010	<0.010	<0.010	<0.010	0.02	<0.010	
Copper	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	
on	0.119	0.025	0.04	0.079	81.1	5.72	<0.019	
ead	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	(0.015) / 0
ercury	<0.0002	<0.0002	0.0002	<0.0002	0.0002	<0.0002	<0.0002	0.002 / 0.002
ickel	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
elenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05 / 0.05
ilver	<0.0004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
hallium	0.007	0.007	0.007	0.007	0.008	0.008	0.002	0.002 / 0.0005
anadium	0.008	<0.006	<0.006	0.007	<0.006	0.006	<0.006	
inc	<0.008	0.013	0.027	0.009	0.113	26.3	<0.008	
NORGANICS (mg/L)								
onductivity (umhos/cm)	675	473	704	501	1060	1640	NR	
hloride	57	15	20	10	46	119	NR	
ulfate	120	103	278	126	48	276	NR	
OD	244	138	534	60	127	235	NR	
itrate\Nitrite - N	6.25	0.63	0.05	0.77	0.05	0.05	NR	10 / 10
ulfide	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	NR	
yanide	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NR	
PA METHOD 8260 (ug/L)								
cetone	<50(14JB)	<50(4.6JB)	<50(4.9JB)	<50(3.3JB)	72 B	<50	<50(5.1JB)	
enzene	<1.0	<1.0	<1.0	<1.0	1.2	1.1	<1.0	5 / 0
arbon Disulfide	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
hloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
hloroform	<1.0 (0.78J)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
2-Dichlorobenzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	600 / 600
4-Dichlorobenzene	<1.0	<1.0	<1.0	<1.0	3.0	3.9	<1.0	75 / 75
chlorodifluoromethane	<1.0	<1.0	<1.0	<1.0	23 D	23 D	<1.0	
1-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0 (0.76J)	12	<1.0	
2-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	1.6	<1.0	5 / 0
1-Dichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7 / 7
s-1,2-Dichloroethene	<1.0	<1.0 (0.28J)	<1.0 (0.63J)	<1.0	33 D	135 D	<1.0	70 / 70
ns-1,2-Dichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	1.2	<1.0	100 / 100
2-Dichloropropane	<1.0	<1.0	<1.0	<1.0	<1.0	2.3	<1.0	5 / 0
hyl Benzene	<1.0	<1.0	<1.0	<1.0	1.7	<1.0	<1.0	700 / 700
ethyl Ethyl Ketone	<1.0	<1.0	<1.0	<1.0	70	<1.0	<1.0	
ethyl Isobutyl Ketone	<1.0	<1.0	<1.0	<1.0	<20 (2.3J)	<1.0	<1.0	
ethylene Chloride	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0 (0.44J)	56 D	5 / 0
trachloroethene	<1.0	2.1	<1.0 (0.41J)	<1.0	<1.0	6.4	<1.0	5 / 0
luene	<1.0	<1.0	<1.0	<1.0	3.3	<1.0	<1.0	1,000 / 1,000
chloroethene	<1.0	<1.0 (0.39J)	<1.0	<1.0	1.5	15	<1.0	5 / 0
chlorofluoromethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
nyl Chloride	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2 / 0
-p Xylenes	<1.0	<1.0	<1.0	<1.0	<1.0 (0.86J)	<1.0	<1.0	10,000 / 10,000
Xylene	<1.0	<1.0	<1.0	<1.0	<1.0 (0.37J)	<1.0	<1.0	
PA METHOD 8151 (ug/L)								
- D	<1.0	<1.0	<1.0 (0.11J)	<1.0	<1.0	<1.0	NR	70 / 70
cthal	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0 (0.17J)	NR	
loram	<0.50 (0.096J)	<0.50	<0.50 (0.091J)	<0.50	<0.50 (0.083J)	<0.50 (0.48J)	NR	500 / 500
,5 - TP (Silvex)	<0.20	<0.20	<0.20	<0.20	<0.20 (0.15J)	0.66	NR	50 / 50
PA METHOD 8270 (ug/L)								
(2-ethylhexyl) Phthalate	<11	<10 (2.7JB)	<11 (2.8JB)	<10	<10	<10 (1.4J)	NR	
-Dichlorobenzene	<11	<10	<11	<10	<10 (1.7J)	<10 (2.2J)	NR	75 / 75
n-Butylphthalate	<11	<10	<11	<10	<10 (0.53J)	<10	NR	
thylphthalate	<11	<10	<11	<10	<10 (3.6J)	14	NR	
Methylphenol	<11	<10	<11	<10	<10 (1.1J)	<10	NR	
ethylphenol/3Methylphenol	<11	<10	<11	<10	62	<10	NR	
enol	<11	<10	<11	<10	<10 (7.5J)	<10	NR	

NR = Not Requested
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
B = Analyte detected in associated reagent blank
D = Value derived from a 10X dilution
E = Value exceeds the high standard used to generate a calibration curve.

TABLE I: ANALYTICAL DATA FOR GROUNDWATER AND QA/QC SAMPLES, OLD SILVER BOW COUNTY LANDFILL
DATE SAMPLED: NOVEMBER 10, 1995

SAMPLE NUMBER WELL ANALYTE (units):	BSB-GW-10 BSB-A6	DRINKING WATER MCL/MCLG
DISSOLVED METALS (mg/L)		
Antimony	0.005	0.006 / 0.006
Arsenic	0.008	0.05
Barium	0.035	2 / 2
Beryllium	<0.002	0.004 / 0.004
Cadmium	0.0384	0.005 / 0.005
Chromium	0.015	0.1 / 0.1
Cobalt	0.08	
Copper	0.004	
Iron	1.31	
Lead	0.003	(0.015) / 0
Mercury	0.0001	0.002 / 0.002
Nickel	0.16	0.1 / 0.1
Selenium	<0.001	0.05 / 0.05
Silver	<0.001	
Thallium	<0.001	0.002 / 0.0005
Vanadium	0.009	
Zinc	17.5	
INORGANICS (mg/L)		
Conductivity (umhos/cm)	2880	
Chloride	60	
Sulfate	1730	
COD	431	
Nitrate\Nitrite - N	0.08	10 / 10
Cyanide	<0.005	
EPA METHOD 8260 (ug/L)		
Benzene	<1.0 (0.41J)	5 / 0
1,4-Dichlorobenzene	1.5	75 / 75
Dichlorodifluoromethane	5.2	
1,1-Dichloroethane	5.8	
1,2-Dichloroethane	<1.0 (0.62J)	5 / 0
1,1-Dichloroethene	<1.0 (0.13J)	7 / 7
cis-1,2-Dichloroethene	66 D	70 / 70
trans-1,2-Dichloroethene	<1.0 (0.57J)	100 / 100
1,2-Dichloropropane	1.1	5 / 0
Methylene Chloride	<1.0 (0.50JB)	5 / 0
Tetrachloroethene	2.7	5 / 0
Trichloroethene	6.0	5 / 0
Vinyl Chloride	1.0	2 / 0

J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
B = Analyte detected in associated reagent blank
D = Value derived from a 5X dilution

APPENDIX C

WELL BSB-A5 SUBSURFACE SOIL ANALYTICAL RESULTS

A Subsidiary of MTC

MSE, Inc. Corporate Office P.O. Box 4078 Butte, MT 59702 (406) 723-8213 FAX (406) 723-8328

Component Development and Integration Facility (CDIF) Butte, MT 59702 (406) 494-7100 FAX (406) 494-7230

July 25, 1995 95MSE487

Doug Richmond
Pioneer Technical Services, Inc.
P.O. Box 3445
Butte, MT 59701

Dear Mr. Richmond:

Please find enclosed analytical results for the soil samples received at the MSE Laboratory July 12, 1994.

If you have any questions, please do not hesitate to call.

Sincerely,

Kevin Kissell

Kevin Kissell
Laboratory Supervisor

KK/rbk

Enclosure

CLIENT: Pioneer Technical Services **Report Date: 7/26/95** **Page 1**
FIELD ID: MW-A5-45 = BSB-A5, 45' bgs
LAB ID: S000568
DATE/TIME SAMPLED: 07/10/95 12:30:0
DATE RECEIVED: 7/12/95
BIF: 000728

GENERAL

Total Organic Carbon (TOC)	<	1.00	mg/kg

PES
Review

CLIENT: Pioneer Technical Services **Report Date: 7/26/95** **Page 1**
FIELD ID: MW-A5-39 = BSB-A5, 39' bgs
LAB ID: S000569
DATE/TIME SAMPLED: 07/10/95 12:15:0
DATE RECEIVED: 7/12/95
BIF: 000728

GENERAL

Total Organic Carbon (TOC)	<	1.00	mg/kg

PES

Review

CLIENT: Pioneer Technical Services **Report Date: 7/26/95** **Page 1**
FIELD ID: MW-A5-27 = BSB-A5, 27' bgs
LAB ID: S000570
DATE/TIME SAMPLED: 07/10/95 11:30:0
DATE RECEIVED: 7/12/95
BIF: 000728

GENERAL

Total Organic Carbon (TOC)	< 1.00	mg/kg

Review

Permeability Test

ASTM D 5084 (Method C: Falling Head, Rising Tailwater)

Project: BHDX-95-142
Laboratory Testing

Date: 08/10/95

Boring: New Well = BSB-A5

Sample: MW-A5-41

Depth: 41'

Sample Description: Silty Clayey Sand, slightly plastic, brown, moist.
Site: Old Butte Landfill (undisturbed)

Initial		Final	
Wt Specimen + Tare Wet:	541.30	Wt Specimen + Tare Wet:	
Wt. Specimen + Tare Dry:	483.80	Wt. Specimen + Tare Dry:	
Vt. Tare:	120.93	Wt. Tare:	
Moisture Content:	15.8%	Moisture Content:	ERR

iameter (in):	2.87	Area, A (cm2):	41.74	Initial Wt. (gm):	663.80
nitial Ht. (cm):	7.7	Initial Dry Unit Wt. (pcf):	111.7	Initial Saturation:	80.9%
inal Ht., L (cm):	7.7	Final Dry Unit Wt. (pcf):	111.7	Final Saturation:	ERR
p. Gravity:	2.758				

urette Area, a (cm2): 1.00

perating Pressures (psi): Cell: 80.0

laximum Effective Consolidation Pressure (psi): 5.0

linimum Effective Consolidation Pressure (psi): 4.0

kempton's B coeficient: 1.0

Permeant Liquid: De-aired, de-ionized water

Head: 75.0 Tail: 75.0

Overburden (psf): 720.0

Overburden (psf): 576.0

	Time (t) sec	H1 cm	H2 cm	hi cm	hf cm	havg cm	Average Hydraulic Gradient	Method C K cm/sec
nitial	0	0.1	49.1	49.0				
Final	46380	3.3	45.9		42.6	45.8	6.0	
esult								2.8E-07
nitial	0	3.3	45.0	41.7				
Final	38880	5.6	42.7		37.1	39.4	5.1	
esult								2.8E-07
nitial	0	5.6	42.1	36.5				
Final	196980	13.8	33.9		20.1	28.3	3.7	
esult								2.8E-07
nitial	0	13.8	30.6	16.8				
Final	71580	15.4	29.0		13.6	15.2	2.0	
esult								2.7E-07
erage Permeability								2.8E-07
igned Permeability								

narks: The specific gravity was assumed for the purpose of saturation calculations.
Preliminary

(4)

Old Butte
#20
CMA

BUTTE-SILVER BOW HEALTH DEPARTMENT
25 WEST FRONT
BUTTE, MONTANA 59701

406-723-3274
FAX 406-723-7245

RECEIVED
MAY 21 1999
MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

May 18, 1999

Terri McLaughlin
Department of Natural Resource Conservation
21 North Last Chance Gulch
P.O. Box 201601
Helena, MT 59620-1601

Dear Terri,

I would like to re-submit the Clark Tailings/Old Butte Landfill Ground Water Control Area Petition previously submitted by the Butte-Silver Bow Health Department. The decision to re-submit the petition has been influenced by the Atlantic Richfield Company's decision to fund the Butte-Silver Bow Water Quality District. With the necessary funding, enforcing the provisions of the petition for the Clark Tailings/Old Butte Landfill Ground Water Control Area can be accomplished. If you have any questions or comments please feel free to contact me at 406-497-5020.

Sincerely,

Dan Dennehy
Health Officer, Butte-Silver Bow

CC:
Dave McCarthy, ARCO
Pat Crowley, DEQ
Kirk Warren, DNRC
Bob Fox, USEPA

Pat:

Could you let me know we are immediately involved in this one. Aside from the funding for the CMA, the dispute is between BSB and ARCO.

We should wait and see how the chips fall.

Rick T.

Rick —

FYI —

I will handle This when I return.

This has major impact on

CMA for Old Butte Landfill and Clark Tails.

Pat

old Butte L.F.
LMA

BUTTE-SILVER BOW HEALTH DEPARTMENT
25 WEST FRONT STREET
BUTTE, MONTANA 59701

[Dated: 11-17-98]

☐ Breast & Cervical Health	(406)497-5080	☐ Maternal/Child Health	(406)497-5080
☐ Butte Lead Program	(406)497-5040	☐ Montana Lead Program	(406)497-5040
☑ Environmental Health	(406)497-5020	☐ Public Health Nursing	(406)497-5080
☐ Family Planning	(406)497-5080	☐ W.I.C.	(406)497-5060
☐ Immunizations Program	(406)497-5080		

FAX # (406)723-7245

☐ City-County Home Health Services (406)497-5000

FAX # (406)782-8150 & (406)497-5011

☐ Chemical Dependency (406)723-4001

FAX # (406)723-4003

TO: Pat Crowley
DEQ

Date: 3/26/99

FAX # 444-1374

FROM: Rick Larson

TOTAL NUMBER OF PAGES (including cover sheet) 7

SUBJECT: Ground water Control Area for the Old Landfill / Clark Tailings

COMMENTS:

CONFIDENTIALITY NOTICE: The documents accompanying this FAX transmission contain CONFIDENTIAL information. All information transmitted is intended only for the use of the above-named recipient. If you are not the named recipient, you are not authorized to read, disclose, copy, distribute or take any action in reliance on the information and any action other than immediate delivery to the named recipient is strictly prohibited. If you are the named recipient, you are not authorized to reveal any of this information to any other unauthorized person and are hereby instructed to destroy the information when no longer needed.

BUTTE-SILVER BOW HEALTH DEPARTMENT
25 WEST FRONT
BUTTE, MONTANA 59701

406-723-3274
FAX 406-723-7245

March 17, 1999

Jack Lynch, Chief Executive
Butte-Silver Bow Courthouse
155 West Granite Street
Butte, Montana 59701

RE: Water Quality District Funding

Dear Jack:

Attached is a recent letter from ARCO regarding continual funding of the Water Quality District Program within the Butte-Silver Bow Health Department. The proposed funding level from ARCO is unacceptable Consequently, I will notify ARCO that the BSB Health Department will no longer be responsible for controlled groundwater areas or anything else associated with Superfund activities relating to water quality issues The water quality district program will end on June 30, 1999.

The Board of Health has directed me to send an official letter to ARCO explaining the department's unwillingness to continue to implement a water quality district program under the terms dictated by ARCO. Historically, the Water Quality District Program funding allocation is $100,000.00 to $125,000.00 per year. The proposal from ARCO is considerably less than it has been for the past five years Consequently, I have no choice but to decline ARCO's offer.

I believe that the Water Quality District Program is essential to the continue success of Butte-Silver Bow's superfund programs. However, I am unwilling to continue the program without a significant commitment from ARCO I believe that my department's continual support for institutional controls is seriously undermined by the lack of financial support from ARCO. It is also my perception that ARCO is posturing for tough negotiation sessions with the local government. In my opinion, Butte-Silver Bow should be equally aggressive and unwilling to compromise this community's health and environmental future for economic incentives that fall far short of what is needed to continue a "waste in place" philosophy

Sincerely,

Dan Dennehy, Director

c.c. Butte-Silver Bow Board of Health
Jon Sesso, Planning Director, TRC Member
Jim Johnston, Public Works Director, TRC Member
Bob McCarthy, County Attorney

BUTTE-SILVER BOW HEALTH DEPARTMENT
25 WEST FRONT
BUTTE, MONTANA 59701

406-723-3274
FAX 406-723-7245

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Sincerely,

Dan Dennehy, Director

c.c. Butte-Silver Bow Board of Health
Jon Sesso, Planning Director, TRC Member
Jim Johnston, Public Works Director, TRC Member
Bob McCarthy, County Attorney

BUTTE-SILVER BOW HEALTH DEPARTMENT
25 WEST FRONT
BUTTE, MONTANA 59701

406-723-3274
FAX 406-723-7245

March 17, 1999

Dave McCarthy, Environmental Engineer
ARCO Environmental Remediation, L.L.C.
307 East Park Street, Suite 400
Anaconda, Montana 59711

RE: Water Quality District Funding

Dear Dave:

Thank you for your March 16, 1999 letter regarding the appropriate level of funding for the Water Quality District (WQD) for the period of July 1999 to July 2000. After reviewing your proposal, the Butte-Silver Bow Board of Health respectfully rejects your offer. The Board of Health feels there is sufficient financial history indicating a minimum of $100,000.00 per year is needed to effectively operate a Water Quality Program. Additionally, ARCO indicated at previous meetings that the WQD program would be funded in perpetuity. Given the historic funding allocation and the previous commitment to our program, your proposal is woefully inadequate.

The Butte-Silver Bow Health Department is unwilling to continue the program past the June 30, 1999 MOU #119 contractual deadline. After this date, ARCO, or its contractor will be responsible for implementing controlled groundwater areas, preparing legislation for adoption of a stormwater ordinance and preparing a drainage master plan.

If you have any questions regarding this information, please do not hesitate to contact me at your convenience.

Sincerely,

Dan Dennehy, Director

c.c. BSB Board of Health
Jack Lynch, Chief Executive
Bob McCarthy, County Attorney
Bob Fox, U.S. EPA

ARCO

ARCO Environmental
Remediation L.L.C.
[illegible]
[illegible]
[illegible]
[illegible]

March 16, 1999

Rick Larson
Butte Silver Bow County Health Department
15 West Front Street
Butte, MT 59701

RE: Water Quality District Issues and Funding

Dear Rick,

As discussed at our March 5 meeting, this letter provides an estimate of an appropriate level of funding for the Water Quality District (WQD) for the period of July 1999 to July 2000 based upon ARCO's expectations related to the WQD.

As described by both BSB and ARCO in the meeting, funding for the WQD, now and in the future, should be based upon appropriate tasks and level of effort for those tasks. During our discussion, it became apparent that there may be a need for ARCO to better understand what tasks are being undertaken by WQD personnel and what, if any, relation these tasks have to ARCO funding. Certain activities that are of primary importance to ARCO include implementation of controlled groundwater areas and adoption of the stormwater ordinance and drainage master plan. Based upon these primary tasks, the attached table was developed to attempt to quantify the appropriate level of funding. The table identifies funding for Superfund related tasks for the period of July 1999 to July 2000 at $12,000. In order to complete the priority tasks identified for the period, we believe the majority of the WQD's effort will be spent on Superfund related tasks as identified on the attached table. Yet, ARCO has provided additional funding for non-Superfund work to bring total funding to $28,911.

Continued funding of the program past July 2000 will be dependent upon the successful completion of the primary tasks within a reasonable time frame. Successful performance of these items will also help ARCO attain a higher level of confidence in allowing the Water Quality District to conduct additional activities such as the monitoring associated with the controlled groundwater areas.

As discussed in our meeting, I will continue to be the point contact for WQD matters. Please direct all written and verbal communication to me. To facilitate information flow, please copy Becky Gleason. Given BSB's budgetary schedule constraints, we may wish to hold a small meeting in the near future to finalize WQD funding issues. Please contact me to set up a meeting.

Sincerely,

Dave McCarthy
Environmental Engineer

C:\My Documents\Pb program\letwqd1.doc

03/16/99

cc: Sandy Stash
Robin Bullock
Chuck Stilwell
Becky Gleason

ZIP!Office Release 1.26

Printed by: Crowley, Patrick at 03/25/99 2:03p

From: Waren, Kirk

Date: March 24, 1999 3:09p

Subject: Butte area Clark Tailings and Old Butte Landfill hearing

--- Attachment: MEMO 1999/03/24 15:07 ----------------------

Date: March 24, 1999
From: Waren, Kirk CN2154 - EX
To: Crowley, Patrick CB5403 - ZI
Subject: Butte area Clark Tailings and Old Butte Landfill hearing

---

Pat,

The hearing for the proposed controlled groundwater area at the Clark Tailings/Old Butte Landfill area is scheduled for:

April 6, 1999 7:00 PM
Boulevard Fire Department, 1900 Franklin Avenue, Butte

NOTE: BSB Local Water Quality District has been considering dropping th petition due to some funding problems between the district and ARCO. Yo want to contact Terri McLaughlin (DNRC Helena Water Resources Regional O manager) sometime close to the hearing date to make sure it is still scheduled. Terri's number is 442-9160.

Kirk W.

County Silver Bow 20
Facility & # Butte
Closure
Finan Assur
[✓ GW Corr Meas]
GW Monitoring
GW Reports
Inspections
Other:

Landfarm
Liner
Methane
O & M
Run - On

Old Butte L.F.
Groundwater CMA

BUTTE-SILVER BOW HEALTH DEPARTMENT
25 WEST FRONT
BUTTE, MONTANA 59701
406-723-3274

RECEIVED
SEP 24 1998
MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

September 23, 1998

Pat Crowley
Dept. of Environmental Quality
1520 East Sixth Ave. P.O. Box 200901
Helena, MT 59620-0901

Dear Mr. Crowley,

The Butte-Silver Bow Health Department will be holding a meeting on October 6th at 1:30pm at the Butte Public Library located at 226 W. Broadway.

The agenda will consist of discussion related to the petitioning for Controlled Groundwater Areas at the following sites located in Butte:

Old Butte Landfill/Clark Tailings site.

Montana Pole Plant/Lower Area One sites.

Mine Flooding Technical Impracticability Study (CGA for the Bedrock aquifer only).

Sincerely,

RL TB

Rick Larson/Todd Bennatt
BSB Health Department

County Silver Bow 20
Facility & # Butte
Closure
Finan Assur
[✓ GW Corr Meas]
GW Monitoring
GW Reports
Inspections
Other:

Landfarm
Liner
Methane
O & M
Run - On

4-3

Old Butte L.F.
Closure
+
Corr Measures

PIONEER
TECHNICAL SERVICES, INC.
P.O. BOX 3445, BUTTE, MONTANA 59702 PHONE (406) 782-5177 FAX (406) 782-5866

May 13, 1997

RECEIVED
MAY 14 1997
MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

Mr. F. Patrick Crowley
Montana Department of Environmental Quality
Permitting and Compliance Division
P.O. Box 200901
Helena, MT 59620-0901

Dear Pat:

Enclosed for your review are the draft design drawings for the passive landfill gas venting system at the Old Butte-Silver Bow Landfill. This venting system is in accordance with the preferred alternative in *the Final Draft, Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment* (January 1997).

As we discussed on the phone, Butte-Silver Bow would like to begin installation of the gas venting system next week. Installation of the cap for the portion of the landfill that received waste after October 9, 1991 would follow installation of the venting system. This cap would be installed in accordance with the preferred alternative in the corrective measures assessment and the Construction Quality Assurance Plan for the Old Butte-Silver Bow Landfill Final Cover Installation (January 1996), which was submitted to you previously.

Feel free to give me a call at 782-5177 with any questions or concerns you may have regarding this plan.

Sincerely,

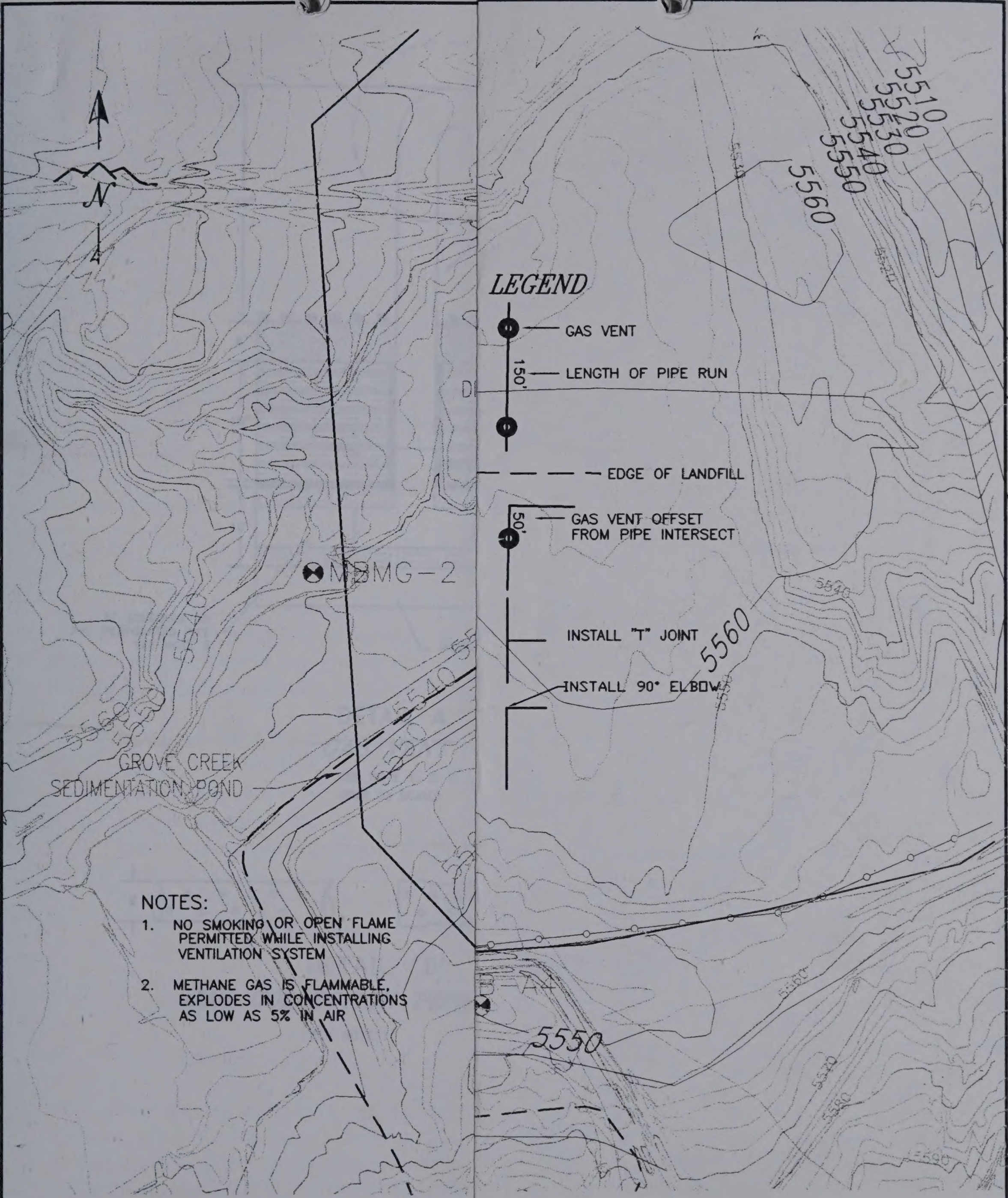
Brad Archibald

Brad Archibald, P.E.
Senior Engineer

Encl.

cc: Jim Johnston, Butte-Silver Bow
Gary Keeler, Butte-Silver Bow

100% post-consumer paper & 100% vegetable based inks


N
LEGEND
GAS VENT
150'
LENGTH OF PIPE RUN
EDGE OF LANDFILL
50'
GAS VENT OFFSET FROM PIPE INTERSECT
INSTALL "T" JOINT
INSTALL 90° ELBOW
5510
5520
5530
5540
5550
5560
MBMG-2
5540
5550
5560
GROVE CREEK SEDIMENTATION POND
5540
5550
5560
5550
5560

NOTES:

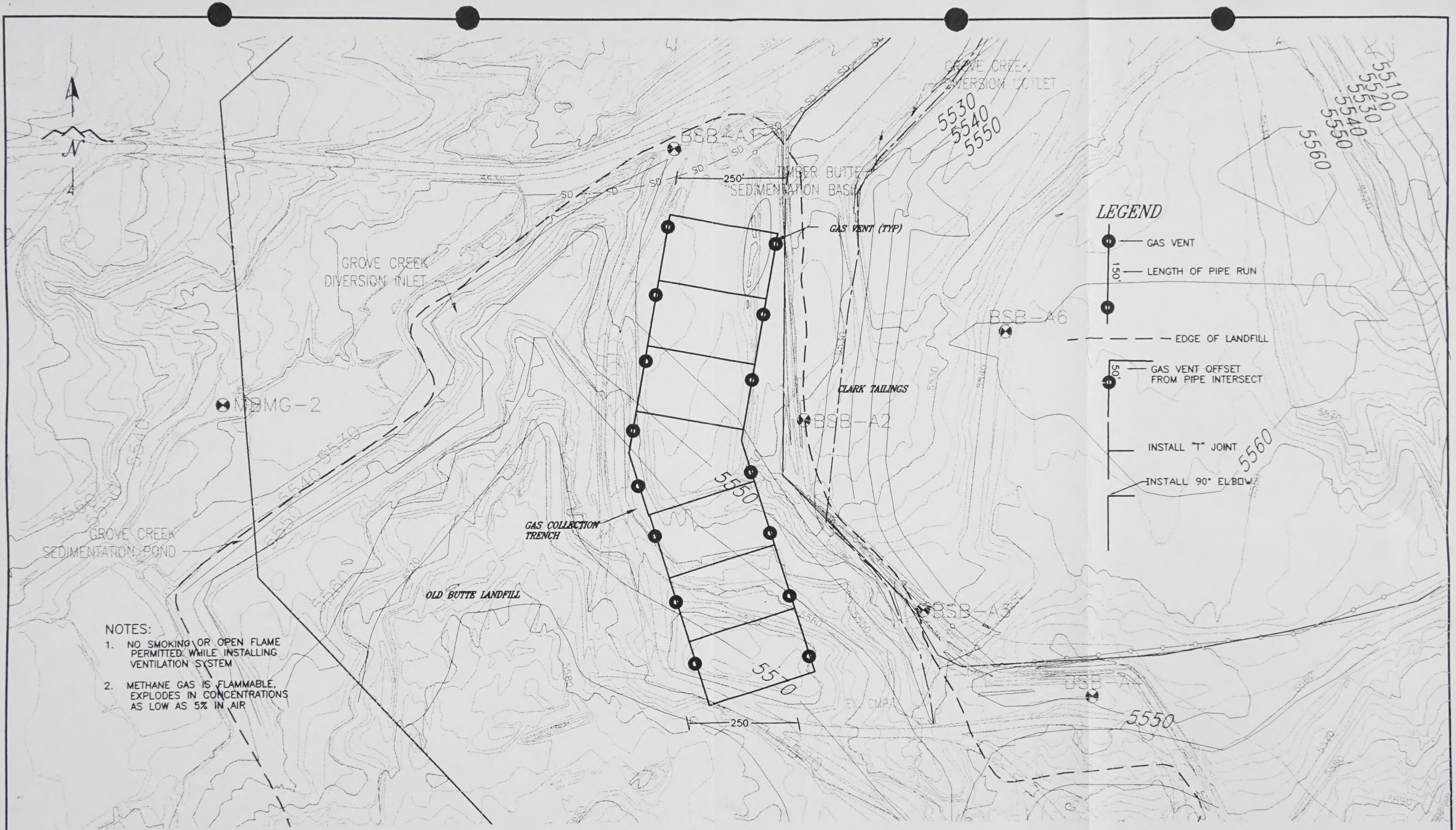
1. NO SMOKING OR OPEN FLAME PERMITTED WHILE INSTALLING VENTILATION SYSTEM
2. METHANE GAS IS FLAMMABLE, EXPLODES IN CONCENTRATIONS AS LOW AS 5% IN AIR

DRAFT

NO.	BY	DATE	REVISION DESCRIPTION

LANDFILL GAS VENTING PLAN

SHT 1


N
BSB-A5
250'
TIMBER BUTTE SEDIMENTATION BASIN
GROVE CREEK DIVERSION OUTLET
5530
5540
5550
5510
5520
5530
5540
5550
5560
SD
GAS VENT (TYP)
GROVE CREEK DIVERSION INLET
BSB-A6
CLARK TAILINGS
MBMG-2
BSB-A2
5540
5530
5560
5550
GAS COLLECTION TRENCH
GROVE CREEK SEDIMENTATION POND
OLD BUTTE LANDFILL
BSB-A3
BSB-A1
5550
250
LEGEND
GAS VENT
150'
LENGTH OF PIPE RUN
EDGE OF LANDFILL
50'
GAS VENT OFFSET FROM PIPE INTERSECT
INSTALL "T" JOINT
INSTALL 90° ELBOW

NOTES:

1. NO SMOKING OR OPEN FLAME PERMITTED WHILE INSTALLING VENTILATION SYSTEM
2. METHANE GAS IS FLAMMABLE, EXPLODES IN CONCENTRATIONS AS LOW AS 5% IN AIR

DRAFT

NO.	BY	DATE	REVISION DESCRIPTION

LT DRAWN
DRC DESIGNED
BOA CHECKED
APPROVED
5/7/97 DATE
9503 PROJECT NO.

SCALE
HORIZ: 1"=200' VERT: 1"=5'
SCALE IN FEET
0 200'

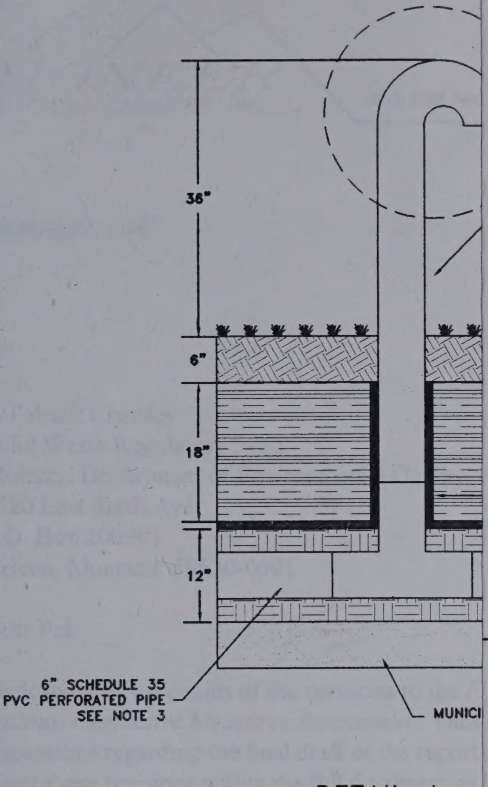
PIONEER TECHNICAL SERVICES, INC.
P.O. BOX 3446
BUTTE, MT 59702

BUTTE-SILVERBOW
OLD SILVER BOW LANDFILL
LANDFILL GAS VENTING

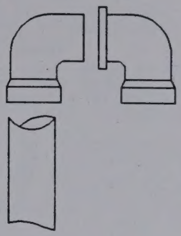
LANDFILL GAS VENTING PLAN

SHEET
1

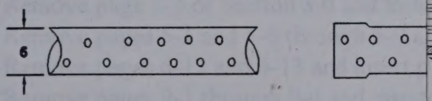
DRAFT


36"
6"
18"
12"
6" SCHEDULE 35
PVC PERFORATED PIPE
SEE NOTE 3
MUNICI

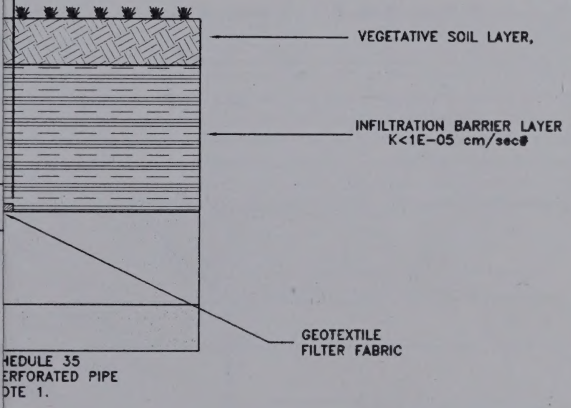
DETAIL A
GAS VENT
SEE NOTE 1, 2, 3.
(NOT TO SCALE)



DETAIL "C"
GAS VENT U-BEND
SEE NOTE 3



DETAIL "D"
GAS COLLECTION PIPE
SEE NOTE 1

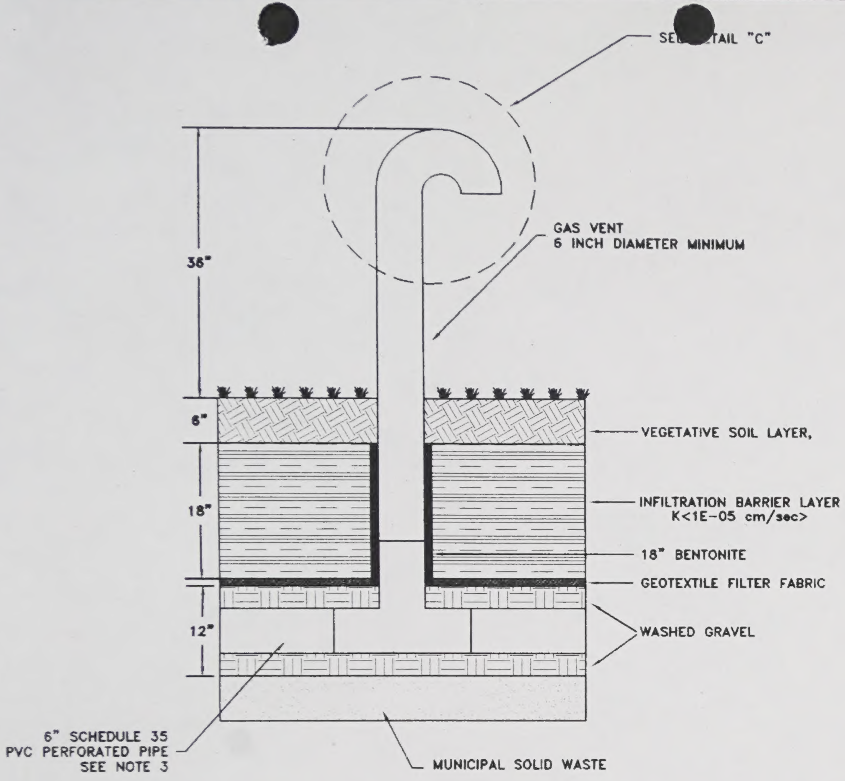

VEGETATIVE SOIL LAYER,
INFILTRATION BARRIER LAYER
K<1E-05 cm/sec#
GEOTEXTILE
FILTER FABRIC
HEDULE 35
ERFORATED PIPE
OTE 1.

NO.	BY	DATE	REVISION DESCRIPTION

TRENCH AND VENT DETAILS

SHEET
2

DRAFT


SEE DETAIL "C"
GAS VENT
6 INCH DIAMETER MINIMUM
36"
6"
18"
12"
VEGETATIVE SOIL LAYER,
INFILTRATION BARRIER LAYER
K<1E-05 cm/sec>
18" BENTONITE
GEOTEXTILE FILTER FABRIC
WASHED GRAVEL
6" SCHEDULE 35
PVC PERFORATED PIPE
SEE NOTE 3
MUNICIPAL SOLID WASTE

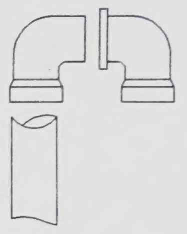
DETAIL A

GAS VENT

SEE NOTE 1, 2, 3.
(NOT TO SCALE)

NOTES:

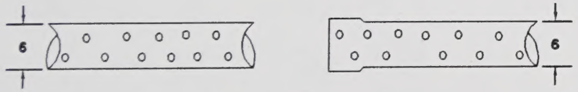
1. GAS COLLECTION PIPES SHALL CONSIST OF 20 FT. LENGTHS OF STANDARD 6 INCH BELLED END PVC PERFORATED PIPE. ALL JOINTS SHALL BE ASSEMBLED SIMPLY BY APPLYING PRIMER AND CEMENT AND PUSHING THE ENDS OF THE PIPE TOGETHER. PIPES SHALL BE BEDDED IN THE CENTER OF THE 1.0 FT DRAIN ROCK LAYER.
2. THE DRAIN ROCK LAYER (3 FT. WIDE, 1 FT. DEEP, 1:1 SLOPE) WHICH SHALL BE INSTALLED APPROXIMATELY 24 IN. UNDER THE LANDFILL CAP. FILTER FABRIC (8 FT. WIDE) SHALL BE LAYED OVER THE TOP OF THE DRAIN ROCK LAYER AFTER THE CAS COLLECTION PIPE IN INSTALLED.
3. THE GAS VENT WHICH IS MADE OF THREE PIECES OF PVC PIPE (4 FT. STRAIGHT PIPE AND 2 - 6IN. - 90 DEGREE ST. ELBOWS) SHALL BE CONNECTED TO THE GAS COLLECTION PIPE BY A T-JOINT. THE GAS VENT SHALL BE APPROXIMATELY 5 FT. IN VERTICAL LENGTH (3 FT. IS ABOVE GROUND). A 6 IN. LAYER OF BENTONITE SHALL BE POURED AROUND THE CIRCUMFERENCE OF THE VENT PIPE WHERE IT INFILTRATES THE FILTER FABRIC.



DETAIL "C"

GAS VENT U-BEND

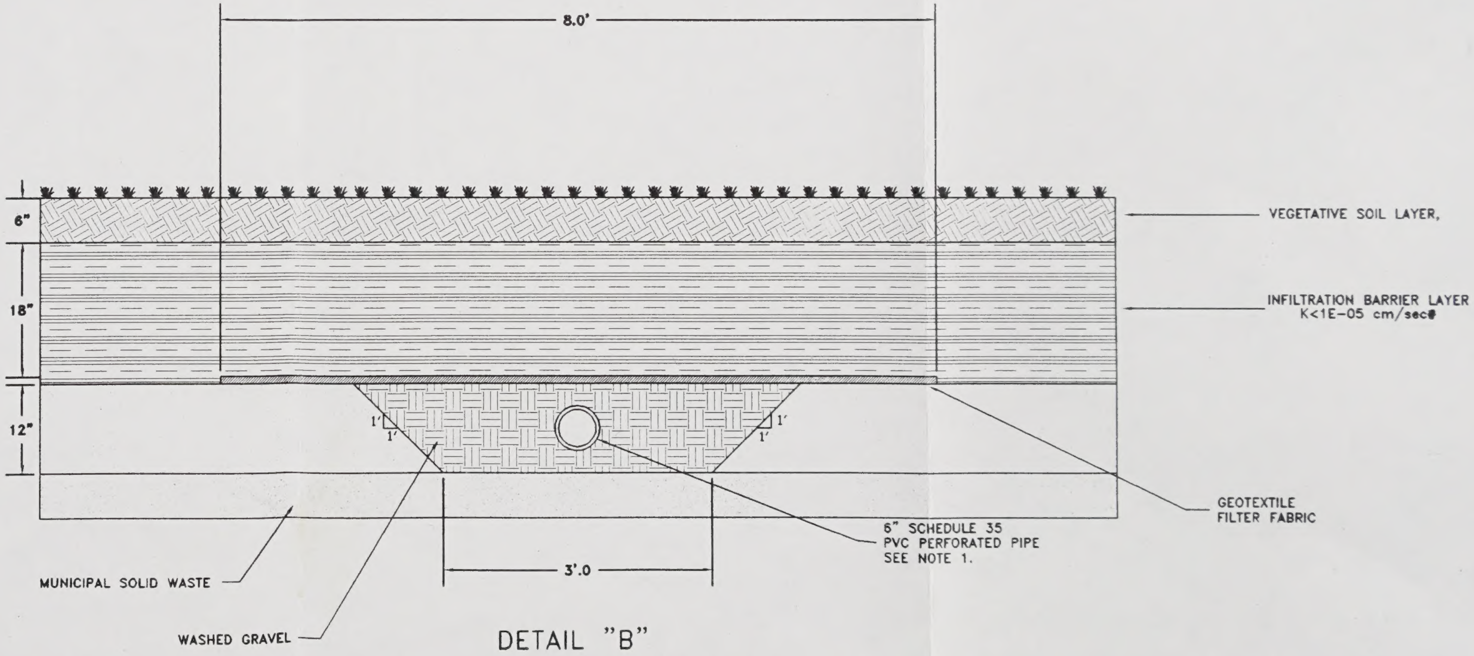
SEE NOTE 3



DETAIL "D"

GAS COLLECTION PIPE DETAIL

SEE NOTE 1


8.0'
6"
18"
12"
1'
1'
1'
1'
3'.0
VEGETATIVE SOIL LAYER,
INFILTRATION BARRIER LAYER
K<1E-05 cm/sec#
GEOTEXTILE
FILTER FABRIC
6" SCHEDULE 35
PVC PERFORATED PIPE
SEE NOTE 1.
MUNICIPAL SOLID WASTE
WASHED GRAVEL

DETAIL "B"

GAS VENT TRENCH CROSS-SECTION

(NOT TO SCALE)

4502-F21

NO.	BY	DATE	REVISION DESCRIPTION

LT DRAWN
DRC DESIGNED
BOA CHECKED
APPROVED
2/21/97 DATE
PROJECT NO.

SCALE
HORIZ: N. T. S. VERT: N. T. S.
SCALE IN FEET
0 N. T. S.

PIONEER TECHNICAL SERVICES, INC.
P.O. BOX 3445
BUTTE, MT 59702

BUTTE-SILVER BOW
OLD SILVER BOW LANDFILL
LANDFILL GAS VENTING

TRENCH AND VENT DETAILS

SHEET
2

Silver Bow Co.
SL Butte L.F #20
~~Closure~~
Ground Water Corr. Measures

CU

PIONEER
TECHNICAL SERVICES, INC.
P.O. BOX 3445, BUTTE, MONTANA 59702 PHONE (406) 782-5177 FAX (406) 782-5866

February 4, 1997

RECEIVED
FEB 05 1997
MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

Pages Replaced
F.P. Crowley
2/5/97
2nd set to K Kirley
for his copy.

F. Patrick Crowley
Solid Waste Regulatory Lead
Montana Department of Environmental Quality
1520 East Sixth Ave.
P.O. Box 200901
Helena, Montana 59620-0901

Dear Pat:

Enclosed are two copies of the revisions to the *Final Draft, Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment*. These revisions are in accordance with our discussions regarding the final draft of the report and my January 29, 1997 letter to you. Please insert these revisions within the full document as described below.

- ✓ Remove Pages ES-1 through ES-3 and insert the attached pages ES-1 through ES-3.
- Remove page iii of the Table of Contents and insert page iii.
- ✓ Remove page 1-1 of Section 1.0 and insert page 1-1.
- ✓ Remove pages 2-1 and 2-5 of Section 2.0 and insert pages 2-1 and 2-5.
- ✓ Remove page 3-3 of Section 3.0 and insert page 3-3.
- ✓ Remove pages 5-1 and 5-6 through 5-9 and insert pages 5-1 and 5-6 through 5-9.
- ✓ Remove pages 6-12 and 6-13 and insert pages 6-12 and 6-13.
- ✓ Remove pages 9-1 through 9-4 and insert pages 9-1 through 9-5.
- ✓ Remove pages 10-1 and 10-2 and insert pages 10-1 and 10-~~2~~. 4
- ✓ Remove page 14-3 and insert page 14-3.
- ✓ Remove Figures 2-4, 6-3, and 11-1 and replace with the updated Figures 2-4, 6-3, and 11-1.
- Insert Appendices F and G.

With these revisions, we intend to proceed to the public meeting portion of the corrective measures process. After we receive your approval, we will issue copies of the referenced report to Ron Bertram, EPA's Butte Office, and the Montana Tech library for public review. A meeting to inform the Butte-Silver Bow Council of Commissioners is scheduled for February 5, 1997 in

the council chambers at 7:30 p.m. The public hearing will follow on February 19, 1997 (also in council chambers at 7:30 p.m.). Your attendance at both of these meetings would be appreciated.

Please give me a call after you have reviewed these revisions.

Sincerely,

Brad Archibald

Brad Archibald, P.E.

Enclosures

cc:
James Johnston, BSB Public Works
Gary Keeler, BSB Public Works
Chuck Stilwell, ARCO
Ron Ziegler, ARCO
Robin Bullock, ARCO
Bill Duffy, PMH&S
Bob Fox, EPA
Neil Marsh, MDEQ
Jon Sesso, BSB Planning
Rick Larson, BSB Health
Eric Jacobsen, ARCO
Sandy Stash, ARCO
Dianne Smith, ARCO
Ron Bertram, EPA
Jim Harris, EPA

In the event that
agreement cannot be
reached, the OBSBLF
~~at Clark~~ will be closed
under the solid waste
Program and the Clark
Tailings will revert
To the Superfund. Priority
soils.

Still reviewing
Group II C+D.

Old Butte LF #20
Draft CMA

Replaced Pages 2/5/97
P Crowley

EXECUTIVE SUMMARY

On December 23, 1994, a letter was received by Gary Keeler of Butte-Silver Bow County/Department of Public Works (BSB) from Pat Crowley of the Montana Department of Environmental Quality (MDEQ)/Remediation Division, Solid Waste Program notifying BSB that the fourth quarter groundwater monitoring results for the Old Butte-Silver Bow Sanitary Landfill (Old Landfill) exceeded the groundwater protection standards for certain constituents of concern (CoCs) listed on Table 2 of Administrative Rules of Montana Title 17, Chapter 50, Subchapter 7, Section 8 (ARM 17.50.708). In the same letter, MDEQ notified BSB that additional sampling was required to be conducted during the first quarter of 1995, and that preparation of a Corrective Measures Assessment was to be completed. This document was prepared to specifically satisfy these requirements.

Pursuant to the agreement reached between MDEQ, the U. S. Environmental Protection Agency (EPA), BSB, Inland Properties, Inc., and the Atlantic Richfield Company (ARCO), the Old Landfill and the adjacent Clark Tailings will be addressed as one unit (hereinafter referred to as the site), since the two sites are contiguous and have similar anticipated end land uses.

A draft corrective measures assessment was submitted to MDEQ in May of 1995. Since that time, additional site characterization data have been collected. Also, BSB and ARCO have participated in on-going correspondence and meetings with MDEQ regarding closure of the site. During this time, EPA has agreed to allow materials excavated from the Lower Area One (LAO) Operable Unit Phase I, Segment II Expedited Response Action (located approximately one mile north of the site) to be placed at the Clark Tailings, under the authority of the MDEQ, Solid Waste Program, if agreed to by MDEQ. MDEQ has expressed agreement with these plans, in concept, and will approve of the plan pending resolution of a few details. (Discussions and correspondence regarding these details are on-going between MDEQ, ARCO, and BSB.) Therefore, the evaluation of alternatives, and the selection of the preferred alternative, is based on the LAO materials being placed at the site.

The objective of this assessment of corrective measures is to identify economically and technically viable alternatives for closing the Old Landfill/Clark Tailings site that will minimize potential threats to human health and the environment. The site history, setting, and available data are presented and analyzed. Remedial technologies are identified and screened. Finally, technologies are organized into viable alternatives, which are screened and then evaluated in detail. Ultimately, a preferred alternative is identified.

The Old Landfill is located approximately one mile southwest of the city of Butte and covers approximately 62 acres. The landfill opened in approximately 1968 and accepted the municipal solid waste from Butte and it's vicinity. The landfill was issued an operating license by the MDEQ in 1978. The landfill stopped receiving municipal solid (Group II) wastes from the public on March 14, 1994 (with the opening of the new Butte-Silver Bow Sanitary Landfill located at Rocker). Some construction and demolition debris is still disposed at the site by BSB

No testing done
for Organics.

contractors, as approved by MDEQ. In the summer of 1994, final cover installation, in accordance with the landfill's closure plan, was started. As of December 1996, 55 of the 62 acres requiring closure had received final cover.

The Clark Tailings cover approximately 60 acres and are located directly east of the Old Landfill. The source of the Clark Tailings was the Timber Butte Mill, which began operation in 1914 and was dismantled in 1948. The Clark Tailings were reclaimed in the mid-1980's as part of the "Clark Tailings Erosion Control Project", by the Anaconda Minerals Company. While much of area was regraded, covered, and revegetated, there are many areas where tailings are currently present at the surface. Vegetative growth on the Clark Tailings is sporadic due to the inconsistent cover thickness.

Future land use plans for the Old Landfill/Clark Tailings site are outlined in the BSB Land Use Master Plan. The future land use is designated as open space/recreational. Current zoning precludes residential development on the site. The recreational uses may specifically include the development of athletic fields, park settings, golfing, and other outdoor recreational facilities.

Groundwater monitoring at the site has detected the presence of contaminants at concentrations exceeding groundwater protection standards in wells beneath the site. Based on statistical analyses, some inorganic and organic constituents were identified as CoCs in wells within the site. Since the submittal of the draft corrective measures report, new wells have been installed at the downgradient boundary of the contiguous site. Selected inorganics exceed groundwater protection standards in some of these wells; no organic CoCs exceeded standards in these wells. Also, sampling of wells downgradient of the site have not detected CoCs at concentrations exceeding groundwater protection standards.

Corrective measures goals for the site are defined primarily by solid waste regulations. Landfill closure regulations at ARM 17.50.530 (for portions of the site which received wastes after October 9, 1991) and MDEQ guidance (for portions of the site that stopped receiving wastes prior to October 9, 1991) contain provisions governing capping of solid waste disposal units. Groundwater protection standards for the site are defined at ARM 17.50.708(5) and require that groundwater protection standards are not exceeded at or beyond the point of compliance. The point of compliance is defined as the a point not more than 150 meters downgradient of the waste management unit and on property owned by the owner of the waste management unit.

Based on the available information, reclamation technologies and process options applicable to the site were identified and screened. Remaining technologies and process options were assembled into alternatives, which were developed, analyzed, and evaluated based on effectiveness, implementability, and cost. Results of the analysis are summarized on Table ES-1.

Based on the results of the detailed analysis, Alternative 8 - Landfill Gas Removal with Capping and Institutional Controls was identified as the preferred alternative. This alternative includes importing the LAO materials to the Clark Tailings portion of the site and consolidating surficial

Time deadline
for corr measures
re: Pb, Cd, Zn.
As. — etc.

tailings from the periphery of the tailings for completing the cap over the landfill in accordance with regulatory requirements and installing a low permeability soils cap over the Clark Tailings. Run-on and runoff controls will be implemented, including a lined pond south of the Clark Tailings, to minimize leachate generation and erosion. The alternative also includes venting of landfill gas to control the source of organic contaminants. Also, institutional controls, including controls on groundwater and land use and a long-term groundwater monitoring program, will be implemented to further protect human health and the environment. After implementation of the corrective measures, the site will be developed as a recreational facility.

LAO materials will be imported and placed at the Clark Tailings in 1997 and 1998. The Clark Tailings cap will be installed as areas are filled to grade and will be completed in 1998. Capping of the landfill, including installation of the gas venting system, will be completed in 1997. Groundwater monitoring of the site will continue as required by the regulations. The recreational complex at the site will be developed after capping activities are completed.

← EPA Approval —
not yet.

1.0 INTRODUCTION

On December 23, 1994, a letter was received by Gary Keeler of Butte-Silver Bow County (BSB)/Department of Public Works from Pat Crowley of the Montana Department of Environmental Quality (MDEQ, formerly the Montana Department of Health and Environmental Sciences)/Remediation Division, Solid Waste Program notifying BSB that the fourth quarter groundwater monitoring results for the Old Butte-Silver Bow Sanitary Landfill (hereinafter referred to as the "Old Landfill") exceeded the groundwater protection standards (GWPSs) for certain constituents of concern (CoCs) listed on Table 2 of Administrative Rules of Montana Title 17, Chapter 50, Subchapter 7, Section 8 (ARM 17.50.708) (Attachment 1). In the same letter, MDEQ notified BSB that additional sampling was required to be conducted during the first quarter of 1995, and that preparation of a Corrective Measures Assessment (CMA) was to be completed. Additionally, the letter suggested combining the closure of the Old Landfill with the Clark Tailings since the two sites are contiguous and have similar anticipated end land use. Therefore, pursuant to the agreement reached between MDEQ, the U.S. Environmental Protection Agency (EPA), BSB, Inland Properties, and the Atlantic Richfield Company (ARCO), the Old Landfill and the adjacent Clark Tailings will be addressed as one contiguous unit under solid waste regulations.

A draft CMA was submitted in May of 1995. Since the submittal of the draft CMA, BSB and ARCO have been conducting additional site characterization efforts to fill the data gaps identified in the draft CMA. During these characterization efforts, BSB and ARCO have frequently met and corresponded with MDEQ to ensure the efforts met regulatory requirements. Also, plans to import materials from the Lower Area One (LAO) Phase 1, Segment II Expedited Response Action to the Clark Tailings have been developed. These plans will allow for more timely completion of the LAO reclamation activities. The regulatory agencies overseeing the LAO removal activities have approved the plans to transport the materials to the Clark Tailings pending approval of the MDEQ, Solid Waste Program. Also, the projected final end use of the combined site as a recreational complex has been refined. This document is an update to the draft CMA. It reflects the comments on the draft CMA provided by MDEQ, the additional data collected since the draft report was issued; the plans to import LAO materials to the Clark Tailings prior to closure of the Clark Tailings; and the projected final use of the combined site.

1.1 ASSESSMENT OBJECTIVES

This CMA addresses the Old Landfill and the adjacent Clark Tailings. The combined Old Landfill/Clark Tailings site is located in portions of Sections 25, 26, 35, and 36 of Township 3 North, Range 8 West in Butte-Silver Bow County, Montana (Figure 1-1). The purpose of this CMA is to summarize available information and consider potential corrective measures for these two adjacent sites.

The Clark Tailings are located immediately east of the Old Landfill (Figure 1-1). Based on letters received from EPA and MDEQ (Attachments 2 and 3), the Clark Tailings are no longer considered a part of the Butte Priority Soils Operable Unit (BPSOU) of the Silver Bow

– State permit not req.

C+D = Group II

2.0 SITE BACKGROUND AND PHYSICAL SETTING

2.1 SITE HISTORY

2.1.1 Old Landfill Site

The Old Landfill is located approximately one mile southwest of the city of Butte (Figure 1-1). The landfill is located at approximately 45° 58' 38" North latitude and 112° 33' 05" West longitude. Covering approximately 62 acres, it lies within portions of the SE¼ of Section 26, the SW¼ of Section 25, the NE¼ and the NW¼ of Section 35, and the NW¼ of Section 36 of Township 3 North, Range 8 West in Silver Bow County, Montana.

The Old Landfill opened in approximately 1968 and accepted the municipal solid waste from Butte and it's vicinity. The landfill was issued an operating license by the MDEQ in 1978 (a permit was not required previously). Since 1978, the landfill has been inspected on a regular basis by MDEQ personnel. Landfilling at the site appears to have used a combination of area and trench landfilling methods.

Grove Gulch historically flowed through the northwestern portion of the site. In the early 1980's, a sedimentation basin was constructed immediately west of the Old Landfill by the U.S. Department of Agriculture/Soil Conservation Service (SCS). Discharge from the sedimentation basin was routed generally north of the historic drainage, along the northwest boundary of the landfilled area (Figure 2-1). At the point where the native drainage meets Little Basin Creek Road (near the northern border of the landfill, see Figure 2-1), Grove Gulch enters a 42-inch diameter reinforced concrete pipe (RCP) culvert, which carries the flow underground until it discharges on the eastern side of the old Burlington Northern Railroad grade, approximately 1,700 feet northeast of the Old Landfill and immediately east of the Clark Tailings.

Run-off from the Clark Tailings and the eastern portion of the Old Landfill is currently conveyed, via a constructed ditch between the tailings and the landfill, to the Timber Butte Sedimentation Basin, located in the northeastern portion of the Clark Tailings site (Figure 2-1). This basin is dewatered by a 36-inch diameter, perforated RCP riser. The basin was designed to allow for the sedimentation of solids from the Timber Butte Mill Site, surrounding adjacent lands, and the Clark Tailings during run-off events. The perforated riser connects to the RCP diversion of Grove Gulch discussed above. The drop inlet and ditch were also constructed in the early to mid-1980's.

The Old Landfill stopped receiving municipal solid (Group II) wastes from the public on March 14, 1994 (with the opening of the new Butte-Silver Bow Sanitary Landfill). Some construction and demolition debris is still disposed at the site by Butte-Silver Bow contractors, as approved by MDEQ (Attachment 4). The construction and demolition debris disposal area is shown on Figure 2-2. The public has not had access to the site for refuse disposal since March 14, 1994.

Survey (USGS) Water Resources Data, Montana, 1984 to 1991, the mean discharge of Blacktail Creek, immediately before it's confluence with Silver Bow Creek, is 10.5 cubic feet per second (cfs). The mean discharge of Silver Bow Creek as it leaves Summit Valley is 22.5 cfs; a significant portion of this flow is the Butte Metro Sewage Treatment Plant discharge, which averages 7.3 cfs. Both of these streams are generally gaining streams through the Summit Valley (ESA, 1991). Grove Gulch, which is diverted around the site, is an intermittent stream which discharges to Blacktail Creek.

2.3.2 Local Geologic Setting

The Old Landfill/Clark Tailings site overlies the western flank of the Quaternary/Tertiary alluvial valley fill in the Summit Valley (Botz, 1969). The landfill monitoring well logs indicate that bedrock was encountered between 30 feet (A3, east) and 60 feet (A1, north) of the surface. Monitoring wells installed at the site indicate that the entire tailings area is probably underlain by alluvium. The underlying bedrock is Cretaceous Butte Quartz Monzonite. Monitoring well locations are shown on Figure 2-3. A geologic cross-section based on these monitoring well logs is shown on Figure 2-4.

2.3.3 Local Hydrogeology

The Old Landfill evidently overlies both the alluvial and bedrock groundwater systems. The northern portion of the landfill and probably most of the Clark Tailings influence the alluvial system. Local static water level measurements from domestic and irrigation wells taken concurrently with one of the landfill groundwater sampling rounds indicate that local groundwater flow travels along the former route (prior to its diversion to the east) of Grove Creek, toward the north-northeast (see Figures 2-5 and 2-6). Transmissivity was measured in the alluvial aquifer at 7,275 ft^2/day at a location 2 miles east-northeast of the landfill site (Botz, 1969).

2.3.4 Local Surface Hydrology

2.3.4.1 Local Drainage

The primary surface water feature in the vicinity of the site is Grove Gulch. This gulch historically cuts across the northwest portion of the landfill property. Grove Gulch is an intermittent stream draining approximately 4.4 square miles (2,800 acres) above the landfill. Most of this drainage basin is semi-arid upland range land. There are some areas disturbed by historic mining prospects. The peak flows associated on different return frequency flow events for this gulch are shown on Table 2-1. These flow values are based on USGS regional regression calculations (Omang, 1992). Note that these are estimated peak flows into the Grove Gulch Sedimentation Pond; peak discharges from the pond will be dampened as a result of the pond's detention capacity.

the site are considered as those from the Timber Butte Site (arsenic, cadmium, copper, lead and zinc).

Four samples collected from the upper two feet of the Clark Tailings have been analyzed for metals content (two samples collected in 1982 and two samples collected in 1987). The following CoC concentration ranges were reported (McCulley, Frick, and Gilman, 1993):

- arsenic 166 to 934 mg/kg;
- copper 314 to 761 mg/kg;
- lead 335 to 1440 mg/kg; and
- zinc 1210 to 4640 mg/kg.

Hydrometrics (1983) reported that one of the samples collected in 1982 contained 35 mg/kg of cadmium, of which 4.64 mg/kg was water soluble. They also reported that a significant fraction of the zinc (397 to 565 mg/kg), manganese (109 to 2375 mg/kg), and arsenic (0.18 to 9.88 mg/kg) in the 1982 samples was water soluble.

During the 1996 CMA investigation, one sample of the Clark Tailings was collected. The sample consisted of a fine quartz sand (tailings) collected from 7.5 to 9.0 feet bgs at BSB-SG1, in the northwestern quadrant of the tailings (the location of this sample is shown on Figure 5-1). The sample was analyzed for metals content and contained the following concentrations of metals:

- arsenic 128 mg/kg;
- cadmium 7.06 mg/kg;
- copper: 676 mg/kg;
- lead: 355 mg/kg; and
- zinc: 2930 mg/kg.

Some metals have been detected in groundwater monitoring wells within and downgradient of the Clark Tailings at concentrations above GWPSs. In particular, cadmium and zinc exceed GWPSs in wells BSB-A6 and CLK-2, respectively. A full statistical analysis of the groundwater contaminants is included in Section 5.1.

5.0 CONTAMINANT ASSESSMENT AND CONCEPTUAL SITE MODEL

In the following sections, site data are evaluated based on the GWPSs and other corrective measures discussed in Section 4.0. Data were collected via groundwater monitoring at the site and additional site characterization tasks completed as part of this assessment of corrective measures, as described in the SAP (Pioneer, 1995). The corrective measures investigation SAP was approved by MDEQ (Crowley, 1996). CoCs are identified, and the nature and extent of their occurrence at the site is presented. Based on this information, a conceptual site model of the site is developed.

5.1 GROUNDWATER

As required by ARM 17.50.708(12), a statistical analysis of the groundwater quality data for the landfill was conducted to determine if any contaminants were present at concentrations greater than the GWPSs defined at ARM 17.50.710(5). The first step in the analysis was the examination and treatment of below instrument detection limit data; the second step was to compare downgradient groundwater quality to GWPSs. The methodology, rationale, and results of this evaluation is discussed in the following subsections. As long-term monitoring data become available, additional statistical comparisons can be performed.

Groundwater quality data from a geoprobe investigation conducted as part of the assessment characterization are also presented.

5.1.1 Treatment of Below Instrument Detection Limit Data

The first step in the analysis of these data was to account for data reported as below the practical quantitation limit (PQL). The PQL is that level above which the laboratory is able to quantify the amount of a particular constituent. A significant fraction of these data from each sampling event were below these quantitation limits for the analytical method and cannot simply be excluded from the evaluation. These data were treated as specified in the regulation [ARM 17.50.708 (13)(e)] which stipulates that a value equal to one-half the method detection limit (MDL) be used in lieu of detected concentrations for statistical evaluation purposes. The MDL is that level above which the laboratory can report with confidence that a particular constituent is present, but may not necessarily be able to quantify the precise amount. The MDL is typically lower that the PQL. The MDLs for each analyte were reported by the laboratory and are significantly lower than the reported PQLs.

Also, the first sampling round, conducted in April of 1993, by SRM, was excluded from the statistical evaluation presented here. This sampling round used different analytical methods, analyzed fewer constituents, and had generally higher PQLs (no MDLs were reported), and hence, were not comparable to the sampling rounds performed after that date. For the above reasons, especially the higher detection limits, these data were not included.

downgradient of a large drainage area east of the landfill, including some portions of Timber Butte, a livestock facility, a trucking facility, and a residential area. Analytical data are included in Appendix B and summarized in Table 5-7. By comparing upgradient to downgradient concentrations, it appears that the site does not significantly degrade surface water quality. While iron and manganese concentrations increase slightly between the upgradient and downgradient sites, the rise could be attributed to contact with steel pipe associated with the Grove Gulch Diversion or other factors. Metals present in the Clark Tailings that are potentially mobile, particularly copper and zinc, do not increase downgradient of the site.

Some metals concentrations from the MBMG data exceed surface water quality standards as defined by the WQB-7 (MDEQ, 1995). The iron HHS of 0.3 milligrams per liter (mg/L) is exceeded at the downgradient location. The downgradient sample means do not exceed the chronic aquatic life standard (CALS) for iron of 1 mg/L. Manganese upgradient and downgradient of the site exceed the HHS of 50 μg/L. There is no CALS for manganese.

Surface water quality data collected by the SCS (reported by Hydrometrics, 1983, and included in Appendix B) indicate that surface water quality in Grove Gulch Creek above and immediately below the site is of comparable quality. Concentrations of arsenic, cadmium, copper, lead, and zinc are comparable just above and just below the combined site (sample locations Grove Gulch 2 and Grove Gulch 5, respectively). Concentrations of iron and manganese have increased below the site. Samples collected from the old (now abandoned) wood and tile flume (sample Grove Gulch 3) contained higher concentrations of some metals, particularly arsenic, copper, lead, and zinc; however, this is apparently due to the entrainment of sediment from the flume with the water sample during sample collection (Hydrometrics, 1983). Samples of run-off from the Clark Tailings also had high concentrations of metals (sample Grove Gulch 4); however, this run-off apparently did not significantly impact surface water quality immediately below the site (sample Grove Gulch 5). Further downgradient of the site (sample Grove Gulch 6, very near the downgradient sample location from the MBMG data set), the concentration of zinc has increased significantly, to levels exceeding acute and chronic aquatic life standards.

5.3 LANDFILL/SOIL GAS

The geoprobe investigation of the site included characterization of soil gas and landfill gas at the site. Landfill gas samples were collected from within the landfill boundary, and soil gas samples were collected beyond the landfill border. Landfill gas was sampled to determine if it was migrating from the site (to ensure compliance with the standards at ARM 17.50.511) and to assess its potential contribution to groundwater contamination.

Soil landfill gas samples were collected from nine locations, shown on Figure 5-1. Samples were analyzed in the field for lower explosive limit (LEL) content (with an O2/LEL meter) and for the VOCs 1,1,1-trichloroethane; cis-1,2-dichloroethene; 1,1-dichloroethane; trichloroethene; and tetrachlorothene (via gas chromatograph). Two split samples were collected and forwarded to Energy Laboratories for VOC analysis via EPA Method 8260. Analytical data are summarized on Table 5-8. The full data report for the laboratory samples is included in Appendix C.

The data show that many of the VOCs in groundwater were also detected during the field analysis of the landfill gas samples, particularly those samples collected from within the landfill (BSB-SG6, SG7, SG8, and SG9). However, the split samples sent to the laboratory did not confirm the presence of these VOCs. The most likely cause of this is the photodegradation of the VOCs between the time they were sampled and analyzed. According to the analytical laboratory, the field data should not be discounted; the VOCs detected by the field gas chromatograph (GC) are most likely present at the concentrations detected in the field (Brown, 1996). This statement is supported by the fact that the water samples split between the field GC and the laboratory correlated very closely for these same constituents (data are included in Appendix C). The soil gas samples collected outside the boundary of the landfill (BSB-SG1, SG4, SG5, SG10, and SG14) show that landfill gas is not migrating from the site. In particular, standards at ARM 17.50.511 are not being exceeded.

5.4 CONCEPTUAL SITE MODEL

The conceptual site model presents the potential routes of human exposure to the waste materials at the site under existing conditions.

Wastes present at the site generally are covered with native soils. However, in some areas of the Clark Tailings cover soils have eroded away and tailings are present at the surface. Therefore, the possibility of exposure, via dermal contact, ingestion, and/or inhalation of airborne particulates, does exist. Access to the site is restricted, however, by a wire-strand fence. Therefore, the current potential to exposure in this manner is limited. However, if the site is developed as a recreational facility, the potential for exposure would increase (with the increased human activity at the site) under existing conditions.

Available surface water quality data (see Section 5.2) indicate that surface water in Grove Gulch is not degraded by the site. However, there is evidence at the site that surface water is cutting through waste materials (including tailings) during run-off events. Discharge from the site enters either the Grove Gulch Sedimentation Pond or the Timber Butte Sedimentation Basin. These structures remove the majority of suspended solids, and associated metals, from the water column. During high flow events, there is the possibility that eroded solids may not be removed from the water column in these sedimentation basins before discharging to Grove Gulch.

GWPSs for some VOCs have been exceeded in wells BSB-A2, BSB-A3 (both immediately downgradient of the landfill), and BSB-A6 (within the Clark Tailings, approximately 450 downgradient of the landfill). Groundwater flow at the site is generally to the northeast, as shown on Figures 2-5 and 2-6. Aquifer materials at the site range from sandy silts to gravelly sands. The two samples of aquifer materials collected at the site (during the installation of well BSB-A5) contained no detectable organic carbon (data are included in Appendix A). Therefore, the capacity of the aquifer materials to attenuate contaminants (both organics and inorganics) is not significant. The groundwater flow velocities vary significantly with the different aquifer materials, and are estimated to range from 1 to 300 feet per year, with an average on the order of 50 feet per year.

While VOCs have been detected in downgradient wells, including BSB-A5, Blankenship's, and the cemetery wells, they do not exceed GWPSs. However, they do exceed GWPSs in the generally cross-gradient well BSB-A6, approximately 400 feet from the landfill boundary.

Based on water balance modeling of the site (performed with the assistance of EPA's Hydrologic Evaluation of Landfill Performance model, see Appendix D) and the watershed above the site, an estimated 9.4 million gallons of water infiltrate through the soils of the basin and become groundwater. Of this, an estimated 18.1% infiltrates through the Old Landfill and 21.5% infiltrates through the Clark Tailings under pre-closure conditions. Groundwater flow, as discussed above, is to the north and east, generally following the topography of the basin.

Based on the data discussed above, the VOC contaminants at the site would be expected to travel toward the downgradient wells (BSB-A5, in particular). However, even though CoCs have been detected in some downgradient wells, no GWPSs have been exceeded beyond the combined site boundary (as determined by the data from wells BSB-A5, Blankenship's, the cemetery wells, and Reap's and the BSB-SG12 geoprobe sampling point). Contaminants present at and near the Old Landfill site boundary (particularly in wells BSB-A2 and BSB-A6) are either degrading (via natural biodegradation), binding to subsurface soils (attenuation), or are being diluted to the point where GWPSs are not exceeded in downgradient wells. Most likely, it is a combination of these phenomena.

Considering the nature of the wastes at the site, the landfill is the probable source of VOC groundwater contamination. Data collected during the assessment of corrective measures process indicate that landfill gas is the probable source of VOCs in groundwater. VOCs are present at concentrations exceeding GWPSs in well BSB-A2; they are present at much lower concentrations in the downgradient well BSB-A5. However, VOC concentrations exceed GWPSs in well BSB-A6, which is cross-gradient from well BSB-A2. VOCs are present in well BSB-A3, generally upgradient of BSB-A6, but at much lower concentrations. Only one VOC (1, 2-dichloroethane) has been detected, at very low concentrations, in well BSB-A4, also upgradient of BSB-A6. This VOC has also been detected in the upgradient well MBMG-2. Furthermore, many of the VOCs present in groundwater were also detected in landfill gas samples from the site. Most likely, landfill gas is migrating to a point near the eastern border of the landfill, particularly during winter when the ground is frozen and does not allow landfill gas to escape to the atmosphere. At this point, it is coming into contact with groundwater, and contaminants are being transferred from the gaseous phase to the aqueous phase. The tailings (in the Clark Tailings portion of the site) consist predominately of fine-grained materials which will inhibit the flow of landfill gas. However, as the pressure of landfill gas builds, it will select the path of least resistance to flow through. As a result, there may be selective migration of landfill gas through the Clark Tailings. This, in turn, may cause localized VOC contamination in groundwater, such as that seen at BSB-A6. This model is supported by the fact that after installation of geoprobe point BSB-SG11, a foam was observed rising in the geoprobe hole. The foam, which evidently was caused by landfill gas escaping from the geoprobe hole, was not observed in any of the other geoprobe points that were installed to groundwater. VOC concentrations in BSB-SG11 were

greater than any of the other geoprobe sample points. Also, the phenomenon of landfill gas causing VOC contamination of groundwater is well documented (Kerfoot, 1994; BFI, 1995).

The source of inorganic contaminants in groundwater is less clear. Metals have been detected at concentrations exceeding GWPSs in wells BSB-A2 and BSB-A6, both of which were installed through tailings. Cadmium, zinc, iron and other inorganics exceed GWPSs in one or both of these wells (Table 5-1). Also, in well CLK-1, zinc exceeds the GWPS. (This well is also downgradient of the railroad grade in addition to the Clark Tailings.) No exceedences were detected in wells further downgradient of the Clark Tailings. The data available show that the Clark Tailings contain metals, and that a fraction of many of the metals, including cadmium, zinc, and arsenic, are water soluble (Hydrometrics, 1983). Thus, the Clark Tailings are the probable source of metals in groundwater beneath the site. The Elm Orlu mine (the source of many of the tailings at the Clark Tailings) was primarily a zinc mine. Therefore, significant concentrations of zinc would be expected in the tailings. Also, greenockite (CdS) was associated with the zinc ores (sphalerite) on the periphery of the copper zones in Butte. Cadmium would not be expected to float with the concentrate in the Clark Mill; therefore, it is likely that there is cadmium present within the Clark Tailings (Ziehan, 1996).

cap by itself (Alternative 3). While it may not directly control VOC groundwater contamination caused by landfill gas (as described for Alternative 3), it would prevent exposure to these contaminants via control of the use and development of local groundwater. Therefore, this alternative is retained for detailed analysis.

6.2.5 Alternative 5 - Low Permeability Capping with Institutional Controls

This alternative consists of importing LAO materials to the Clark Tailings, capping of the landfill and Clark Tailings, hydraulic (run-on/run-off) controls, and institutional controls. The alternative is very similar to Alternative 4, except that a less permeable cap (exceeding capping requirements at ARM 17.50.530 for areas that received waste after October 9, 1991) will be installed on the Clark Tailings portion of the site.

The Old Landfill will be capped with native soils satisfying solid waste regulations in the same manner described in Alternative 3. The Clark Tailings will be capped with a multi-layer cap consisting of, from bottom to top: 18-inches of low permeability native soil (in the range of 1 x 10^{-5} cm/sec to 1 x 10^{-7} cm/sec); six inches of a capillary break/drainage material; and 18-inches of cover soil/vegetative growth media. A typical cross section of the Clark Tailings cap under this alternative is shown on Figure 6-3. Based on covering 52 acres (after consolidation of the Clark Tailings), approximately 126,000 cy of the low permeability materials will be required. Native silt or clay materials from the LAO excavation or native clayey sands from a pit immediately north of the site will be used for the low permeability infiltration barrier layer.

Areas that will be paved, such as parking areas and roads, as part of the planned recreational complex at the site may be capped in a different manner. These areas (shown of Figure 9-3) may be capped with a native soil cover overlaid by base coarse (which will serve as capillary break and drainage layer and will improve strength to the overlying asphalt) and flexible asphalt pavement. The asphalt pavement will act as the infiltration barrier layer. These areas will be graded to promote run-off. The pavement will be designed to minimize cracking potential, and asphalt will be strictly maintained to fix any cracks or holes. This is similar to the portions of the cap installed at the Old Works/East Anaconda Development Area Operable Unit near Anaconda, Montana.

A lower permeability cap is not planned over the entire landfill based on the premise, discussed in Section 5.4 (Conceptual Site Model), that landfill gas is the most likely source of VOC contamination, not leachate from the landfill. Additionally, water balance modeling shows that the native soils cap offers a comparable level of effectiveness (because of evapotranspiration) with respect to infiltration. In this case, installing a lower permeability cap over the landfill would not be any more effective at achieving GWPSs for VOCs. Installing the cap over the Clark Tailings would reduce leachate generation rates from baseline conditions, and, therefore, the flux of contaminants to the groundwater. In this manner, concentrations of inorganics in groundwater will be reduced. Also, the low permeability cap in this alternative will satisfy solid waste regulations for areas that receive waste after October 9, 1991, which will be the case when the LAO materials are placed at the site.

Materials from the LAO Operable Unit would be imported to the Clark Tailings site prior to closure. These materials would be placed and compacted in a manner conducive to future development as a recreational complex. The approximate final grading with the LAO materials imported is shown on Figure 6-2.

Prior to capping and after placing the LAO materials, the Clark Tailings site would be graded to prevent run-on and promote run-off. These storm water controls would include measures to prevent uncontrolled ponding and infiltration of water upgradient of the wastes. As part of this effort, a lined, engineered storm water pond will be installed south of the Clark Tailings. The grading plan would be intended to prepare the site for use as a recreational complex after closure. Grading would include consolidation of some surficial tailings with the rest of the tailings to minimize the surface area covered by tailings, and, therefore, minimize the potential for leachate generation and migration of contaminants to groundwater.

The low permeability soil for the Clark Tailings cap would most likely be clayey sands from the Hollow borrow pit north of the site. In situ testing of test pads constructed from these soils showed their permeability to range from 1.6 x 10^{-7} cm/sec to 5.2 x 10^{-7} cm/sec, when compacted to an average of 96.7% of their standard Proctor density (Pioneer, 1996b). Alternatively, native silts and clays from the LAO Operable Unit, which will be removed as part of that remedial action, may be used for the infiltration barrier layer. These materials would be used if they do not leach unacceptable levels of metals and are approved by MDEQ. The in situ permeability of these materials ranged from 1.3 x 10^{-7} cm/sec to 6.8 x 10^{-7} cm/sec, when compacted to an average of 96.1% of the standard Proctor density (Pioneer, 1996b). Investigations of these sources of materials show that there is an adequate volume of these materials available to provide the 126,000 cy necessary. Capillary break/drainage layer materials would consist of a gravel (ranging primarily from 3-inch to 3/4-inch particle size, with less than 10% fines) available at a pit near Crackerville, Montana (approximately 10 miles west of Butte). Cover soil/growth media will most likely come from borrow sources southwest of the landfill; the Hollow pit north of the site; ARCO-owned sources west of the LAO Operable Unit (approximately 2.5 miles northwest of the Clark Tailings), or clean soils from the west end of LAO.

In addition to the low permeability layer, the presence of the capillary break will also mitigate infiltration (and the potential for leachate production) by increasing evapotranspiration (Stormont, et al, 1995) and will minimize upward wicking (caused by capillary rise) of water from the tailings to the vegetative root zone.

In addition to capping and hydraulic controls, institutional controls will be implemented at the site. These controls would include deed restrictions to prevent the development of the site in a manner inconsistent with the wastes present at the site and the BSB Land Use Master Plan; implementing a GWCA through the BSB Water Quality District and DNRC that would restrict the use of the affected aquifer; and a post-closure groundwater monitoring program. These institutional controls would be effective in preventing exposure of contaminants to humans.

9.0 PREFERRED ALTERNATIVE

Alternative 8, Landfill Gas Removal with Capping and Institutional Controls, is the preferred alternative for addressing groundwater contamination at the Old Landfill/Clark Tailings site. The alternative is expected to meet the goals of the corrective measures process identified in Section 4. It satisfies the evaluation criteria as well as or better than the other alternatives, as described in Section 8. The alternative applies conventional, implementable technologies to address the groundwater contamination at the site. It will meet or exceed regulatory standards for landfill closure.

The alternative is expected to achieve GWPSs for metals (particularly cadmium and zinc) through the installation of a low permeability cap over the primary source of these contaminants, the Clark Tailings. First, the Clark Tailings site will be graded to promote run-off from the waste areas and prevent run-on to these areas. A lined pond will be installed south of the tailings in an area that currently ponds. This ponded water currently evaporates or infiltrates; infiltration raises the groundwater table, possibly into the Clark Tailings in some areas. By installing a lined pond and reducing this upgradient infiltration, the amount of groundwater contacting the Clark Tailings, and, therefore, the flux of metals from the tailings to the groundwater, will be reduced. This pond may also be used as an irrigation source for the planned recreational facilities at the site. Other hydrologic controls will include interceptor berms and run-off ditches to convey water off the site as quickly as possible while minimizing erosion. This, in turn, will also minimize infiltration.

Prior to installation of the cap, the tailings will be consolidated as much as practicable to minimize the area requiring a cap. This will primarily involve excavating the surficial tailings from the periphery of the Clark Tailings. The excavated materials will be placed on top of the Clark Tailings. The excavated areas will be backfilled with clean cover soil and graded to promote drainage. Then, the materials from the LAO will be imported to the site and placed over the Clark Tailings. These materials will be placed in a manner conducive with the intended use of the site for recreational facilities. This will include placing and compacting the materials in a manner that will allow development of the site. In general, materials will be placed at a minimum of 90% of their maximum dry density, as determined by ASTM D698. Under areas on which permanent improvements may constructed (such as structures or parking lots), the materials would be placed to a minimum of 95% of their maximum dry density. The area will be graded to promote run-off and in preparation for its use as a recreational facility.

After preparation of the Clark Tailings site is complete, the cap itself will be installed. The cap is designed to significantly reduce infiltration and the resulting generation of leachate. A typical cross-section of the cap is shown on Figure 6-3. The cap will consist of a prepared subgrade overlaid by 18 inches of low permeability soils (on the order of 1.0E-05 to 1.0E-07 cm/sec) as an infiltration barrier layer. Installation of these materials will be monitored closely to ensure consistent low permeability throughout this crucial layer. Over the infiltration barrier layer, a six-inch layer of coarse materials will be placed. This layer will serve several purposes. First, as

a capillary break it will prevent the capillary rise of contaminants from the waste materials to overlying soils. This will, in turn, help to ensure a healthy vegetative cover. Secondly, as a drainage layer, it will provide a highly permeable medium for which water that has infiltrated through the overlying cover soils to drain by gravity from the cap before infiltrating through the infiltration barrier layer. This will decrease the overall head on the infiltration barrier layer and the overall leachate generation rate. The coarse materials will also prevent the downward growth of roots, preventing root damage to the underlying barrier layer. Over the capillary break/drainage layer, a 12-inch layer of cover soil will be installed and then an additional 6-inch seed bed layer will be added. These soils will provide a medium for vegetative growth and will also provide a reservoir for moisture storage. In other words, these soils will store moisture until such a time that it can be evapotranspired. In this way, the amount of water infiltrating through the cap is reduced.

Areas that will be paved, such as parking areas and roads, as part of the planned recreational complex at the site may be capped in a different manner. These areas may be capped with a native soil cover overlaid by base coarse (which will serve as capillary break and drainage layer and will prove strength to the overlying asphalt) and flexible asphalt pavement. The asphalt pavement will act as the infiltration barrier layer. These areas will be graded to promote run-off. Run-off will account for the majority of the water balance in these areas, rather than evapotranspiration. The pavement will be designed to minimize cracking potential, and the asphalt will be maintained to promptly fix any cracks or holes. This is similar to the portions of the cap installed at the Old Works/East Anaconda Development Area Operable Unit near Anaconda, Montana.

A detailed final grading plan for the Clark Tailings, after placement and compaction of the LAO materials and installation of the cap, is shown on Figure 9-1.

Infiltration of precipitation through the landfill is not expected to be a major source of groundwater contamination, as explained in Section 5. Therefore, a cap designed to comply with regulatory standards will be installed at the landfill portion of the site. The majority of the earthwork for the landfill cap has been completed; as of December 1996, approximately seven acres require additional capping, as explained in Section 6.2.3. The additional cover will be installed and the entire area will be finish-graded and revegetated. This cap will reduce infiltration by providing positive drainage from the site and increasing the evapotranspiration. The vegetated cap will minimize erosion and the mobility of wastes by the surface water pathway. It will also prevent exposure to wastes via direct contact and airborne-migration of wastes.

A passive landfill gas venting system will be incorporated into the landfill cap in the northeastern portion of the landfill (the area where GWPSs for selected VOCs have been exceeded). This system will be designed to collect and vent landfill gases to the atmosphere, thereby decreasing the landfill gas pressure within the landfill and the resulting migration of landfill gas, contact with groundwater, and transfer of VOCs from the gaseous to the aqueous phase. This system

will remove the source of the VOC contamination, preventing further groundwater degradation. VOCs presently in the groundwater will be treated intrinsically, and GWPSs for VOCs will be achieved with time. A schematic for the landfill gas venting system is shown on Figure 9-2.

In addition to these measures, institutional controls will be implemented to ensure protection of human health. These controls will consist of restrictive covenants placed in the property deeds to prevent their development in a manner that may lead to exposure of contaminants to humans. Also, the zoning for the area will be maintained as recreational/open-space to prevent residential development. The groundwater monitoring program at the site will be continued, as explained in Section 10. This plan will measure the effectiveness of the implemented corrective measures and will also be used to ensure that contaminants are not migrating from the site to downgradient users of the affected aquifer. Furthermore, a GWCA will be instituted, via the BSB Water Quality District and DNRC to prevent the development and/or use of the affected aquifer in a manner that may be harmful to human health and the environment. The aquifer could not be used as a potable water supply. Also, the aquifer could not be used in the vicinity of the site for industrial or other large-scale uses that may create a regional cone of depression that may lead to contaminant migration.

Groundwater monitoring conducted after capping is completed and landfill gas venting is implemented will be used to measure the effectiveness of the implemented alternative. With respect to VOCs, landfill gas venting will control the source of contamination. Therefore, improvements in water quality can be expected in the time frame for currently contaminated water to travel beyond the monitoring points (in particular well BSB-A6). (Note that beyond this monitoring point, VOCs are apparently treated intrinsicly since no exceedences of GWPSs have been observed beyond this point.) It is known that groundwater contamination exists at the landfill border (as evidenced by BSB-A2 and BSB-A3). Based on an estimated aquifer hydraulic conductivity of 1.0E-03 cm/sec, groundwater travel time from the landfill border to BSB-A6 would be on the order of years. Also, contamination has apparently moved cross-gradient (from BSB-A2 and BSB-A3 to BSB-A6), which leads to the conclusion that landfill gas in the source of VOCs. Based on this information, improvements in VOC concentrations may be observed in BSB-A6 in five to ten years.

Improvements in groundwater quality with respect to inorganics will be driven by the time for water to drain from the Clark Tailings and travel to the monitoring points. Based on a hydraulic conductivity of the tailings of 5.0E-05 cm/sec and an average depth of 47 feet (22 feet through tailings and 25 feet through alluvium overlying the aquifer) to the aquifer, it will take from three to four years for the water currently within the tailings to drain to the aquifer. Once it reaches the aquifer, travel time to the point of compliance will also take several years, based on an estimated hydraulic conductivity of the aquifer materials of 1.0E-03 cm/sec. Therefore, improvements in groundwater quality at the point of compliance are anticipated in eight to ten years. It may take a few flushes of the aquifer before all residual metals in the aquifer are removed and GWPSs for inorganics are achieved at the point of compliance.

After implementation of these corrective measures, the area may be developed as a recreational complex. An architect's rendering of the potential layout of the facilities is shown on Figure 9-3. The grading plan for the closure of the site is intended to be conducive to the development of these recreational facilities. Construction of facilities such as these may require the installation of an irrigation system. If this is the case, the lined pond south of the Clark Tailings may be used for water storage. In addition to the surface water that flows into the pond, groundwater extraction wells may be installed in the vicinity of the site. These wells would be located in a manner that would not extract contaminated groundwater that may be inappropriate for irrigation. Irrigation of capped waste areas would be planned so as to not lead to the generation of more leachate than is predicted naturally. In the conceptual plan, irrigation is planned only over the Clark Tailings, which includes a low permeability cap, a drainage layer, and an 18-inch cover soil/evapotransporation layer.

10.0 CORRECTIVE MEASURES GROUNDWATER MONITORING PLAN

The existing groundwater monitoring wells at the site are shown on Figure 2-3. Wells BSB-A1, BSB-A2, BSB-A3, and BSB-A4 were installed in 1993 for groundwater monitoring at the Old Landfill. The other wells have been installed since as part of the assessment of groundwater contamination and corrective measures process.

Upon implementation of the selected corrective measure alternative, well MBMG-2 (the background well) will be monitored semi-annually in accordance with ARM 17.50.710(1)(a)(v). Wells BSB-A1, BSB-A5, CLK-1, and CLK-2 will be the point of compliance wells for the combined site. Therefore, in accordance with ARM 17.50.710(1)(a)(v), they will be monitored semi-annually for all Table 1 constituents and any previously detected Table 2 constituents. Other point-of-compliance wells may be added in the future if necessary and additional lands downgradient of the site are acquired by BSB. Any new wells will be approved by MDEQ before installation. The assessment monitoring analytical plan is described below.

Semi-Annual (Table I and Table II detects) Monitoring

Wells MBMG-2, BSB-A1, BSB-A5, CLK-1, and CLK-2	Field Parameters (pH, temp.) Specific Conductance, Chloride, Sulfate Chem. Oxygen Demand, Nitrates Dissolved Metals Cyanide Volatile Organics (Method 8260) Semi-Volatile Organics (Method 8270) Chlorinated Acids (Method 8151)

Annual (full Table II) Monitoring

Wells MBMG-2, BSB-A1, BSB-A5, CLK-1, and CLK-2	Field Parameters (pH, temp.) Specific Conductance, Chloride, Sulfate Chem. Oxygen Demand, Nitrates Dissolved Metals Cyanide Sulfide Volatile Organics (Method 8260) Semi-Volatile Organics (Method 8270) Chlorinated Acids (Method 8151) Organochlorine Pesticides & PCBs (Method 8081)

In addition, well BSB-A6 (which currently exceeds GWPSs for certain VOCs) will be monitored quarterly for VOCs (via EPA Method 8260) to assess the effectiveness of the implemented alternative at addressing VOC contamination.

Data from wells CLK-1 and CLK-2 will be used to measure the effectiveness the implemented alternative at addressing inorganic groundwater contamination. Because of the long period anticipated before GWPSs will be achieved at these wells, they will not be monitored any more frequently than semi-annually (as required by ARM 17.50.710(1)(a)(v)) to determine the effectiveness of this alternative at achieving inorganic GWPSs.

Wells BSB-A2, BSB-A3, and BSB-A4 will be impacted by the planned corrective measures. Wells BSB-A2 and BSB-A3 will be impacted by grading and drainage controls planned for the site. Well BSB-A4 will be impacted by the planned storm water pond south of the Clark Tailings. These wells will no longer define the point of compliance for either the landfill or the Clark Tailings. Therefore, they will be abandoned during construction of the corrective measures improvements.

The groundwater monitoring plan would revert to detection monitoring, in accordance with ARM 17.50.710(2) when the contamination levels drop to background levels. Post-closure monitoring would continue for 30 years after closure of the site is completed in accordance with ARM 17.50.721.

Groundwater sampling procedures will be in accordance with the groundwater sampling SOPs approved by MDEQ.

Pioneer, 1995, *Sampling and Analysis Plan for the Butte-Silver Bow Landfill/Clark Tailings Assessment of Corrective Measures Investigation*, prepared for Butte-Silver Bow Department of Public Works, December.

Pioneer, 1996a, *Draft Construction Quality Assurance Plan for the Clark Tailings Disposal Area Cap*, prepared for Atlantic Richfield Company, September.

Pioneer, 1996b, *Construction Quality Assurance Plan for the Old Butte-Silver Bow Landfill Final Cover Installation*, prepared for Butte-Silver Bow Department of Public Works, December.

Potts, Pat, 1993. MDEQ letter to E. Handl, SRM.

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PTI, 1991b. *Clark Fork River Superfund Site Investigations, Data Management/Data Validation Plan,* prepared for ARCO, Anaconda, MT, September 1991.

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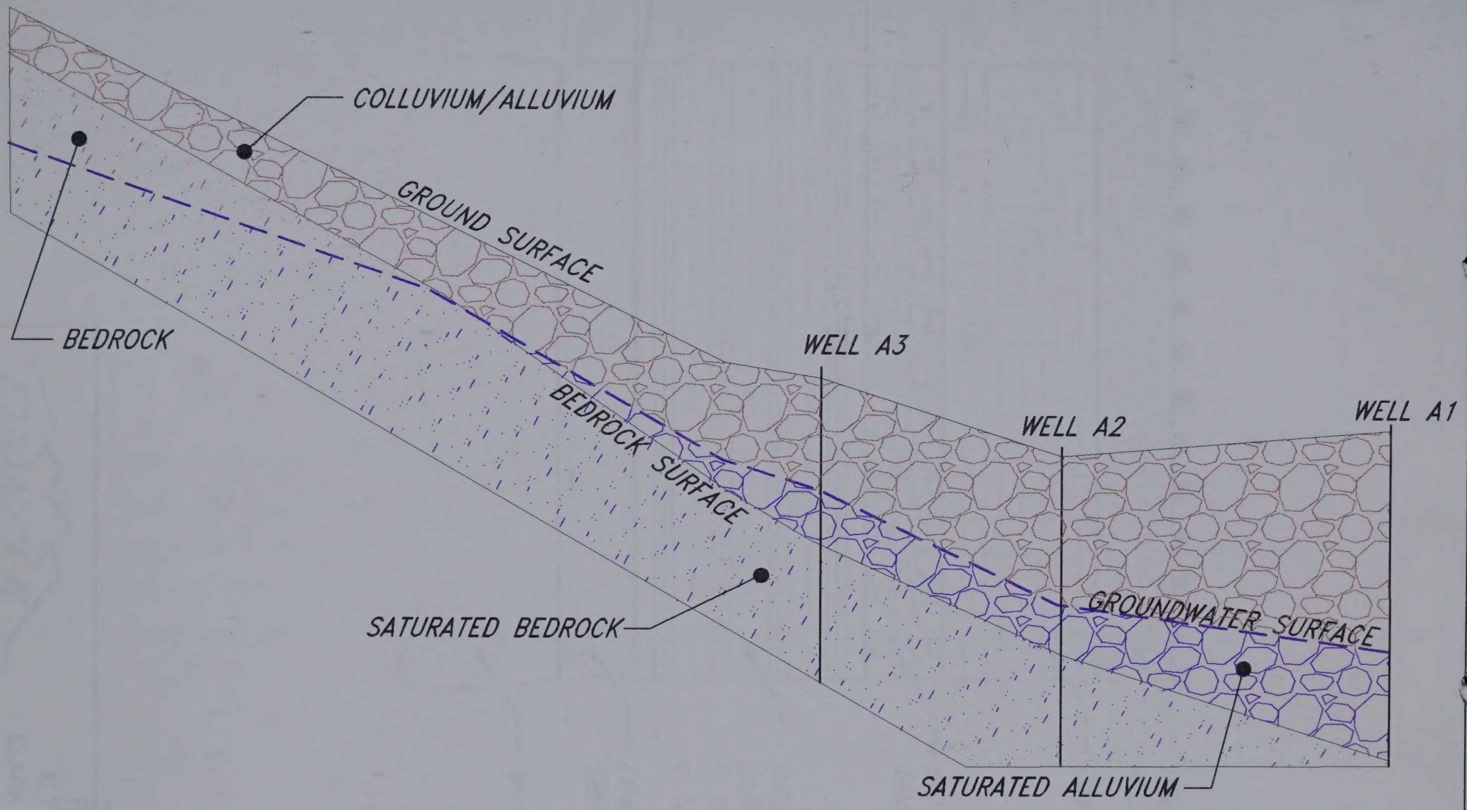
COLLUVIUM/ALLUVIUM
GROUND SURFACE
BEDROCK
WELL A3
WELL A2
WELL A1
BEDROCK SURFACE
SATURATED BEDROCK
GROUNDWATER SURFACE
SATURATED ALLUVIUM

10 FEET

300 FEET

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FIGURE 2-4
SITE GEOLOGIC
CROSS SECTION

SCALE: AS NOTED
DATE: 1/97

4502-F17

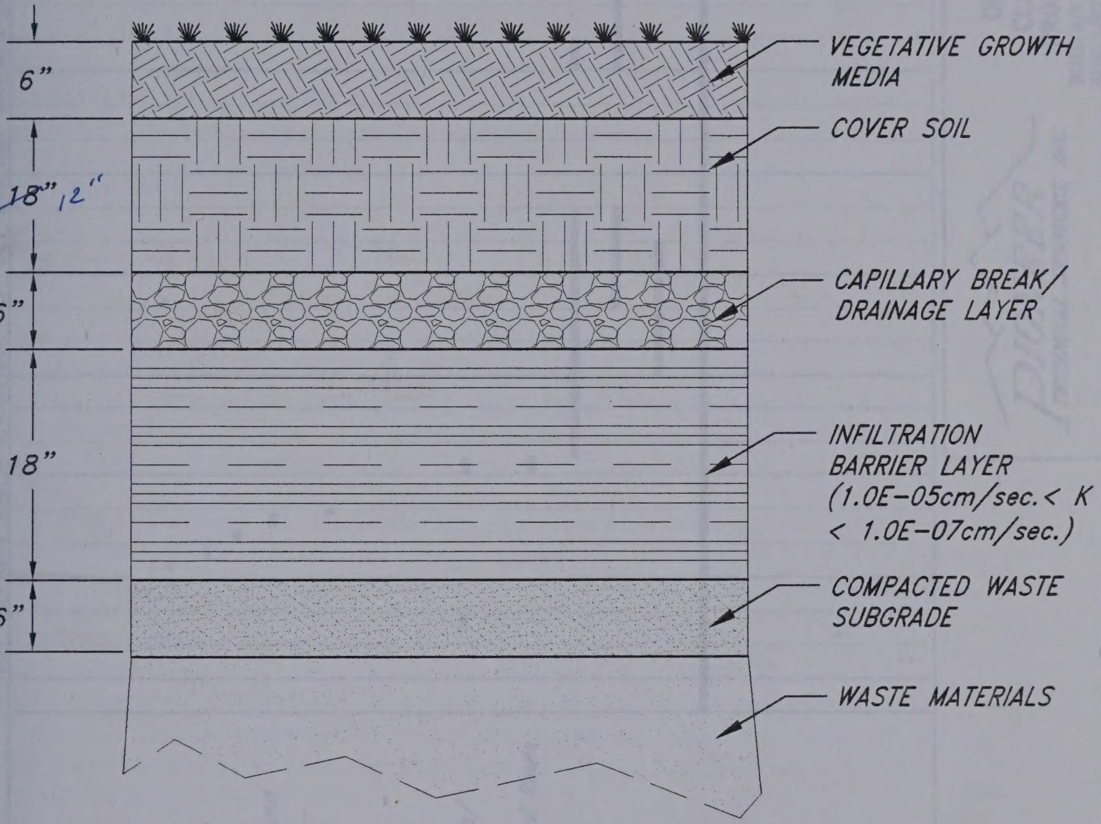
6"
~~18"~~ 12"
6"
18"
6"
VEGETATIVE GROWTH MEDIA
COVER SOIL
CAPILLARY BREAK/ DRAINAGE LAYER
INFILTRATION BARRIER LAYER (1.0E−05cm/sec.< K < 1.0E−07cm/sec.)
COMPACTED WASTE SUBGRADE
WASTE MATERIALS

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FIGURE 6−3
ALTERNATIVE 5
CLARK TAILINGS CAP

SCALE: N/A
DATE: 12/19/96

4502−F01

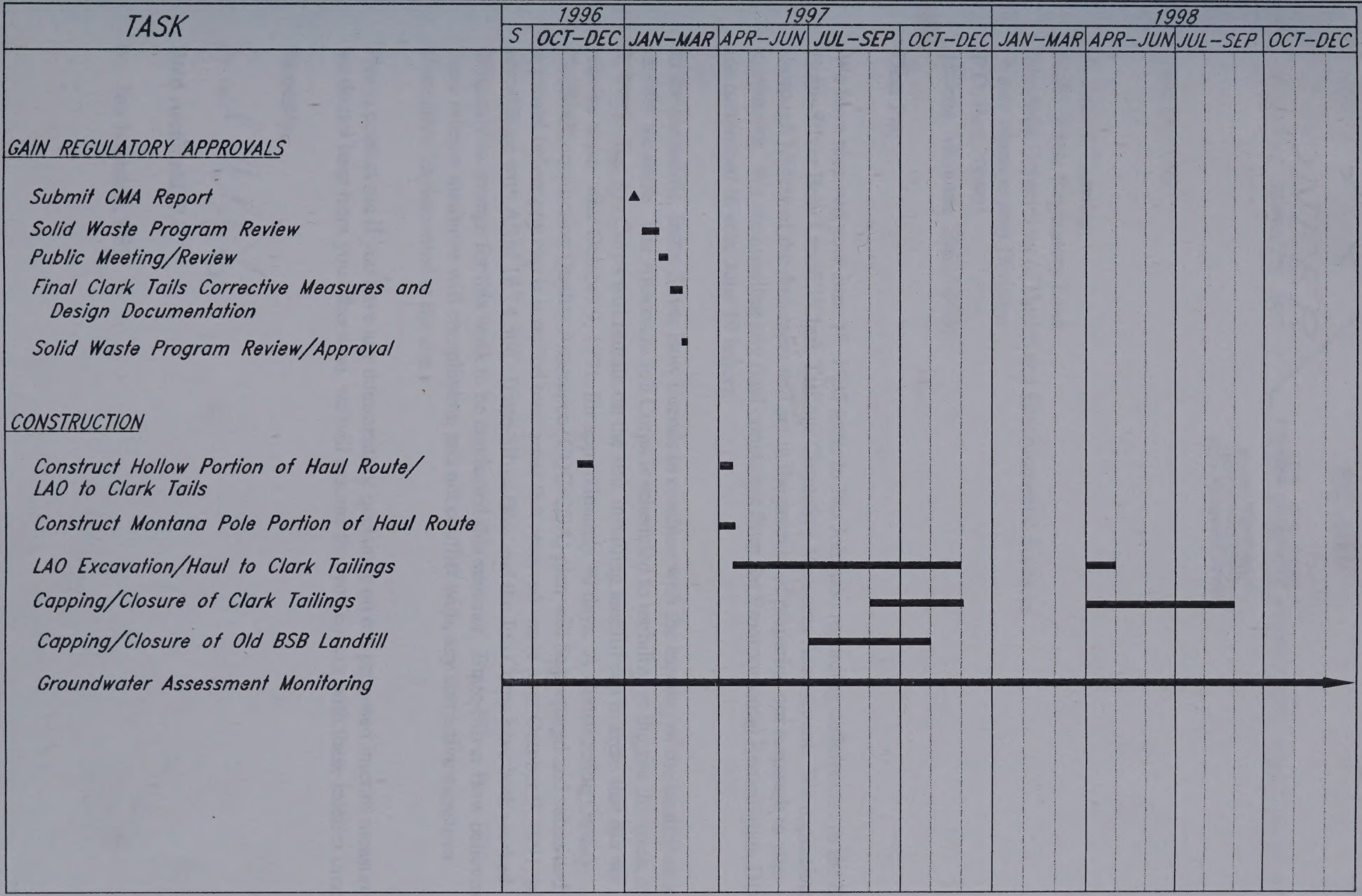

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FIGURE 11-1
OLD LANDFILL/
CLARK TAILINGS
PROJECT SCHEDULE

SCALE: N/A
DATE: 1/97

4502-F11

file
Old Butte
Closure

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TECHNICAL SERVICES, INC.
P.O. BOX 3445, BUTTE, MONTANA 59702 PHONE (406) 782-5177 FAX (406) 782-5866

RECEIVED
JUL 03 1995
Montana Department of
Environmental Quality
Waste Management Division

June 29, 1995

F. Patrick Crowley
Solid Waste Regulatory Lead
Montana Department of Health and Environmental Sciences
Waste Management Division
P.O. Box 200901
Helena, Montana 59620-0901

Dear Pat:

We have received your June 19, 1995 letter to Jim Johnston regarding deficiencies in the Draft Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment. We appreciate your thorough review of the document and are in the process of preparing our response to your comments. We are awaiting any final comments from the Environmental Remediation Division (as mentioned in your June 19 letter).

In the meantime, Butte-Silver Bow intends to continue with the capping of the landfill as an interim measure. The Anaconda Job Corps is scheduled to mobilize to the site the week of July 3, 1995. The Job Corps will remain on the site, installing landfill cap in areas that did not receive waste after October 9, 1991, for approximately 90 days. A Construction Quality Control/Construction Quality Assurance (CQC/CQA) plan will be prepared and submitted for approval before any cap is installed over areas that received waste after October 9, 1991, in accordance with ARM 16.14.506. Butte-Silver Bow and the Job Corps have both worked diligently to arrange for this work to be conducted this summer. Butte-Silver Bow believes that these interim measures will compliment, and not conflict with, any corrective measures alternative implemented at the site.

Please contact me if you have any comments or questions on our proposed interim measures. If we do not hear from you otherwise, we will assume that you concur with these interim measures.

Sincerely,

Brad Archibald, P.E.

cc: Jim Johnston, BSB

100% post-consumer paper & 100% vegetable based inks

RCT RCT 6/23
JD JD
File: Old Butte L.F. Closure.

MEMORANDUM

Date: June 22, 1995

To: Pat Crowley, Solid Waste Program

From: James O. Scott, SPO - Silver Bow Creek/Butte Area NPL site

Subject: Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment

==

The following comments are based on a review of the draft document *Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment*, prepared by Pioneer Technical Services, Inc., for Butte-Silver Bow Government (BSB). These comments are a compilation of my work and the Montana Bureau of Mines and Geology (MBMG).

GENERAL COMMENTS:

- In a letter dated March 23, 1994, from Bob Robinson, Director MDHES, to Jack Lynch, Chief Executive Butte-Silver Bow Government, conditions were outlined for having the Solid Waste Program assume authority for corrective action. As of this date, these requirements have not been met. There is no official agreement between ARCO, Inland Properties (owner of the Clark Tailings) and BSB. There is no agreement ("MOA") between the parties on regulatory authority issues. Until there is resolution on these issues, attention should be given to proceeding further.

- The document must satisfy both RCRA requirements and Superfund requirements. The document has totally ignored Superfund requirements. For example, the corrective action must meet federal and state Applicable, Relevant and Appropriate Requirements (ARAR's); a risk assessment for contaminants of concern is required; etc.

- Characterization of the Clark Tailings as outlined in past communication by MDHES to BSB was not included in the draft document. The installation of twelve monitoring wells, see attachment A, to characterized tailings depth and water quality will generate the data needed to develop remediation alternatives.

- This document is lacking from both a groundwater and surface water perspective. A number of statements made in this report are too broad, to general, or just incorrect. These points will be discussed in detail in the Specific Comments section.

- Background wells have not been established for the site; MBMG-2 is **not** a background well; conclusions using MBMG-2 as a background well are likely to be incorrect.

- As MBMG data is used in this document, it should be cited and included as a reference in the text.

SPECIFIC COMMENTS:

- Executive Summary, sixth paragraph: Current law (Superfund) does not regard "current" land use and zoning in limiting remediation selection. Consolidation, removal, or partial removal of the Clark Tailings should not be excluded from evaluation as a remediation alternative.

- Page 10, Sections 2.3 and 2.3.1 "Geology, Hydrogeology, and Hydrology" and "Regional Setting:" This section(s) is based on a single 1969 document? With the extensive Superfund coverage since the mid 1980's to present in easy access, this section(s) prove to be week and require updating. Examples follow, but this is only a selection of examples.

- Page 11, second paragraph, fifth and sixth sentences: The statements are incorrect. Butte Mine Flooding documents (e.g., RI, FS, ROD) do not make such conclusions. The bedrock aquifer is and has been shown to be a viable (usable) aquifer at numerous locations throughout the Butte Basin/Summit Valley.

- Page 11, third paragraph: There is considerably more data (recent) than Botz '69 and it should be used. Data is available from sources such as the Silver Bow Creek Phase I and II RI's, MT Pole RI, etc..

- Page 11, fourth paragraph, fourth sentence: Statement about gaining streams is too broad/general, they need to discuss these streams in greater detail, possibly by areas were they gain and lose. An example being that both Blacktail and Basin Creeks are losing streams in the south end of the Basin (valley), but are gaining in areas from Harrison Ave. west (below confluence of Basin and Blacktail). Evaluation of Grove Gulch, by section (i.e., upgradient, past and under, and downgradient), as a gaining/loosing stream needs to be evaluated.

- Page 12, top of page, first complete sentence: Please give reference for underlying bedrock being "Cretaceous Butte Quartz Monzonite." Recommend using "Preliminary Geologic Map of the Northwest quarter of the Butte South Quadrangle" (1960-1963) by Harry W. Smedes.

- Page 12, top of page, last sentence and Page 13, Figure 2-4: Was Well A4 used in the construction of this Figure? It is not indicated as such. Why the 10 feet vertical to 300 feet horizontal? This makes the topography appear much more sloped that it actually is. Why were other cross-sections not constructed?

- Page 12, second paragraph, last sentence: Transmissivities in the Summit Valley alluvial aquifer vary greatly. Is this the only value for the area; again what can be found in current Superfund documents? Is there any data from the MT Tech field course that participated in the installation of the monitoring wells at the site?

- Page 12, third paragraph: What happened to the historic wooden culvert that ran under the landfill? Was it removed or left in place? If it was left in place, include as a feature on future site maps.

- Page 12, fourth paragraph: HEC analysis for peak flows in Grove Gulch as well as the USGS regional regression calculations are required. The information presented in this document with the information for the Grove Gulch Sedimentation Pond (page 15, second paragraph) suggest a need to revisit the issue from a storm water perspective.

- Page 14, Figure 2-5: There is too little data to produce this map in the detail presented here. Much of the area should not be contoured at all, and where it's possible, the contour interval should be no smaller than 15 feet. This figure shows groundwater flowing nearly the opposite of what has been found to be the case at both the MT Pole and MT Power sites.

- Page 15, first paragraph, last sentence: What does SCS stand for. The design and improvements for the Grove Gulch Sedimentation Pond should be included for future reference.

- Page 15, fourth paragraph, first sentence: Does RCP stand for reinforced concrete pipe? This illustrates the need to have an abbreviation page added to this and all future documents.

- Page 16, second paragraph: All data collected by SCS should be included or provided for reference.

- Page 20, Section 3.2 "Clark Tailings:" The data presented for waste characteristics are incomplete and inadequate to characterize the Clark Tailings. As stated in the third general comment above, further characterization of the Clark Tailings is required.

- Page 23, fourth paragraph, first sentence: As stated previously, well MBMG-2 is not a background monitoring well. According to Figure 2-5, it is downgradient of the far NW portion of the landfill. With out a background well, this section is dubious.

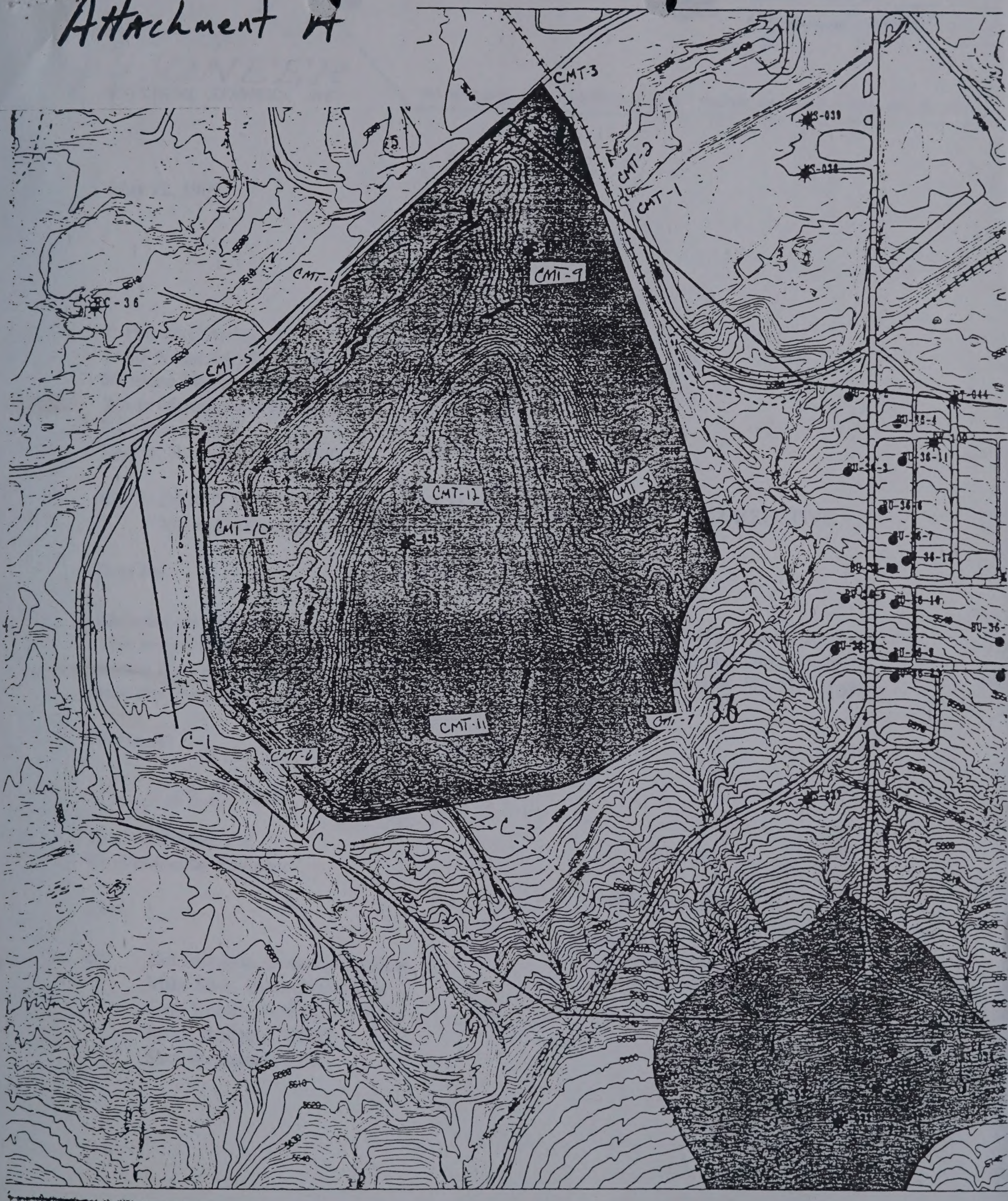
- Page 30, third paragraph: Much of the paragraph is in error. The downgradient site, GC-2, near MT ST., is above the livestock, trucking, and residential areas mentioned in the text. The actual sampling site was at the far east end of the Clark Tailings. Approximately 0.7 mi separate the upgradient (GC-1) and downgradient (GC-2) sites, with a majority of the area in between being the old landfill and Clark Tailings. In addition to the increase for iron and manganese noted in the text, chloride, sulfate,

arsenic, and zinc also increase. SC increases and pH decreases between sites , also indicating a change in water quality. The document neglects the increase in flow rates between these sites in their evaluation. The increase in chloride concentrations could be an indication of contaminant movement from the old landfill, as it has zero retardation; also the increase in sulfate concentrations could be from the tailings.

- Page 33, third paragraph, first sentence: The statement is incorrect. The data (MBMG) **does** indicate a change (impact) in surface water quality from above to below these sites.
- Page 33, "Development And Screening Of Alternatives:" Consolidation is an alternative requiring further consideration.
- Page 41, Removal/Solids Removal/Screening Comments: The statement that "...not implementable at this site due to volume of waste present," is an incorrect and unsubstantiated statement. Remove the restriction and retain for subsequent evaluation.

c: files

Attachment H


CMT-3
CMT-2
CMT-1
CMT-9
CMT-4
C-36
CMT-5
CMT-12
CMT-8
CMT-10
CMT-11
CMT-7
36
C-1
CMT-6
C-2
C-3

old Butte
groundwater

PIONEER
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May 12, 1995

F. Patrick Crowley
Solid Waste Regulatory Lead
Montana Department of Health and Environmental Sciences
Waste Management Division
P.O. Box 200901
Helena, Montana 59620-0901

RE: DRAFT BUTTE-SILVER BOW LANDFILL/CLARK TAILINGS CORRECTIVE MEASURES ASSESSMENT

Dear Pat:

Enclosed are three copies of the above referenced report. I'd appreciate it if you could distribute it for review within MDHES. After your review of the report, we'd like to meet with you to discuss it's contents. In the meantime, please don't hesitate to give me a call at 782-5177 if you have any questions.

Sincerely,

Brad Archibald

Brad Archibald, P.E.
Environmental Engineer

RECEIVED
MAY 15 1995
Montana Department of Health
and Environmental Sciences
Waste Management Division

Encl.

cc: Jim Johnston, Butte-Silver Bow
Mike Shea, Butte-Silver Bow
Gary Keeler, Butte-Silver Bow
Robin Bullock, ARCO
Sara Weinstock, EPA

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